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ABSTRACT

The study, exploration, and debate of relations between universities, world information systems, and communication networks seeking to establish a sustainable system to handle recent developments in information and communication, utilizing universities as focal points, was continued at this third annual conference attended by 31 information professionals from eight nations. Commemorative remarks by Tefko Saracevic, Gjuro Dezelic, Neva Silovic, and Robert M. Hayes honored the memory of Dr. Bozo Tezak, the conference founder. A panel discussion exploring the topic of education in the fields of information and communication is summarized in remarks of the major contributors and the closing comments of Robert M. Hayes. A selection of papers presented on a variety of general and specific subjects is included: "Information and Productivity" by Robert M. Hayes; "A 'LINC' between University Library, Information and Computing Services Using Voice Input/Output" by John Hawgood; "Information Measurement Systems" by Sergei Prohorov; "Issues in Distributed Data Base Design" by Abdullah Uz Tansel; and "International Standardisation of Modular University Programmes" by Gustav Thuro. The conference closed with a joint statement noting progress and accomplishments and suggesting directions for future studies and conferences. Lists of resource persons and participants are appended. (RAA)

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PROCEEDINGS

of the Conference

UNIVERSITIES IN WORLD NETWORK OF INFORMATION AND COMMUNICATION III

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IRCEBS

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

held in Dubrovnik, May 20-23, 1980

IR009049

EDITORIAL

The Conference 'Universities in World Network of Information and Communication' was organized for the first time in 1977 due to the efforts of the late professor Božo Težak. In 1979 the second conference was held, in 1980 the third one.

The 1980 Conference was preceeded by a Course entitled 'Information, Computer, Education'. During the Course only tutorial State of the Art lectures were delivered. Due to their length (200 pages) we cannot include them in this issue. The Course papers will be published in a less formal way as a Course Textbook.

Here we shall present only the 1980 Conference held in the Interuniversity Centre for Postgraduate Studies in Dubrovnik, 13-23 May, 1980. On the eve of the Conference Professor Božo Težak passed away, but (directors, resource persons and) participants decided to run the Conference in this way honouring his work. The Conference has been divided into three consecutive events: Panel, Conference Papers, Conclusion and Joint Statement.

a) The subject of the Panel was 'Education and Training in Information and Documentation'. The Chairman was Professor Stanko Turk. The major contributions as well as the Panel Summary are presented here.

b) Conference papers were presented by most of the participants/resource persons. Some of the presentations concentrated on general subjects and others were more specific. A selection of conference papers is presented in this Proceedings. The most outstanding presentation was that of Dean R.M. Hayes. It represents the backbone of the Conference.

c) The conclusion and the Joint Statement session was held on the last day and is presented in this issue.

The list of participants from eight countries is also given.

Branko Souček

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PROCEEDINGS

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UNIVERSITIES IN WORLD NETWORK OF INFORMATION AND COMMUNICATION III

held in Dubrovnik, May 20-23, 1980

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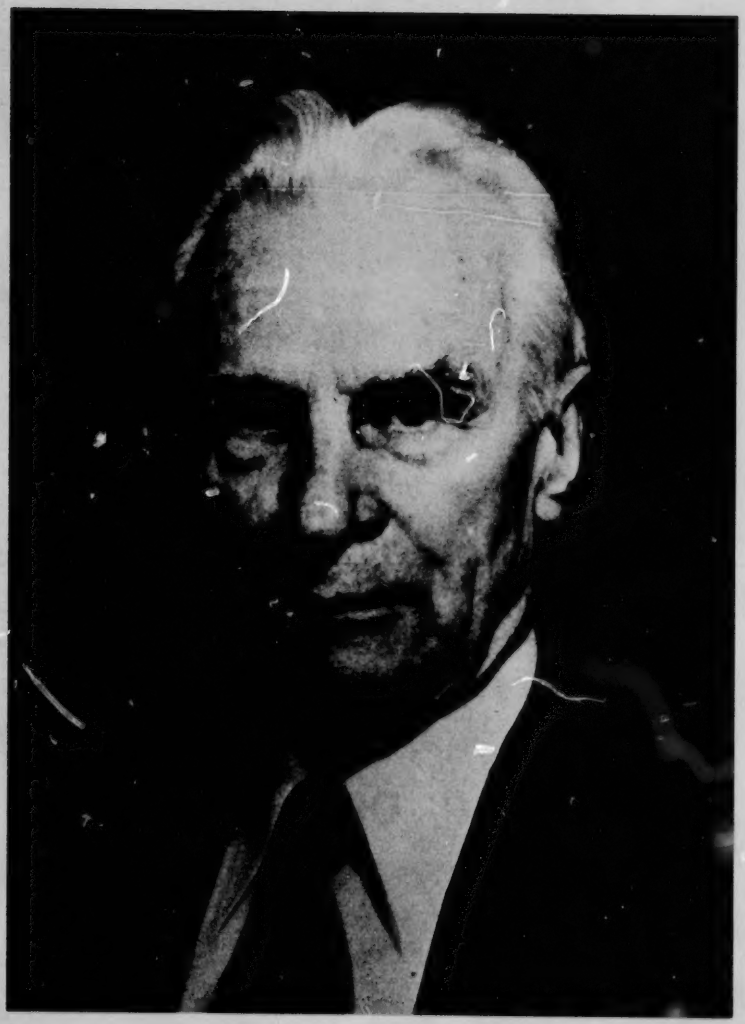
COMMEMORATION
FOR PROFESSOR DR. BOŽO TEŽAK

May 20, 1980



Božo Težak
1907 - 1980

IRCIHE Bull. 6 (1-2) 1-9 (1980)

Tefko SARAČEVIĆ

The first session this morning as you have seen from your programmes, is a memorial session for Prof. Dr. Božo Težak. We are all here because of Božo Težak. We organized this particular session not only to commemorate Božo Težak, but to explore his ideas and his work. We organized this session in the hope that his work and his ideas will be continued. We organized this not to look into the past but to look into the future. It is my personal honour to chair this particular session and there is a very personal note that I want to share with you: if it were not for Prof. Težak I would not be here. I would not know you. I would not be involved in all this and be knowledgable of the professional activities in this field in this country. So thanks to Prof. Težak I am in contact with my colleagues. Our first speaker today will be Prof. Gjuro Deželić. I would dispense with lengthy introductions. He will be talking about the professional life and activities of Dr. Težak.

Gjuro DEŽELIĆ

Three years ago, during the editorial work on Professor Težak's *Festschrift*, nobody could even imagine that this great personality of our scientific and university life would not be with us any more. This *Festschrift*, designed and published as a special anniversary volume of *Croatica Chemica Acta* (*CCA*, Vol. 50, 1977) on the occasion of Professor Težak's 70th birthday and 25 years of his work as Editor-in-Chief of *Croatica Chemica Acta*, is itself a monument dedicated to the extraordinary career of a man who devoted his entire life to science, a man who left so many traces of broad activity in the scientific community. The *CCA* anniversary volume contains 31 scientific papers covering chemical topics, from colloid stability, the precipitation phenomena and polymer chemistry, to general and theoretical chemistry as well as biochemistry. Twelve papers were contributed by leading scientists in the field of colloid chemistry from Belgium, Denmark, Hungary, the Netherlands, United Kingdom, USA and USSR. In the history of primary scientific publishing in Yugoslavia this was a unique gathering of the international scientific community wishing to acknowledge Professor Težak's 50 year presence in world science and his founding the 'Zagreb school of colloid chemistry'. In the field of colloid chemistry there exists no example of such broad recognition of scientific achievements.

Prof. Težak deserves without doubt another *Festschrift* in the field of the information and communication science, where his achievements and merits can be measured accordingly. Unfortunately, his unexpected death has put an end to such endeavours, leaving to his friends and pupils to follow his visions and ideas and to analyse his great opus.

In a moment when our feelings are deeply engaged with the memory of Prof. Težak, it seems most appropriate to dwell on his professional life and activities. This can be done only partly, since his unusually fruitful life gives us so many facts, that only a thorough and elaborate analysis could entirely cover this *spiritus movens* in science, education and information. This has to be left to the coming generations.

Božo Težak was born on July 27th, 1907 in Varaždin (Croatia, Yugoslavia). In 1930 he received his chemical engineering degree at the Technical Faculty of the University of Zagreb.

During the 1930-1931 period he worked in the Ramsay laboratories of Inorganic and Physical Chemistry with Prof. Donnan at the University College of the University of London. This period left a deep impression on the young man. Firstly, he entered the world of colloid chemistry where he received international recognition for his fundamental scientific contributions which can be summarized numerically: 126 papers with about fifty researchers, most of which received their doctorates in his laboratory, two invitations to the well-known Faraday Society Discussions in England (1954, 1966) and the invitation to the VII Mendeleev Congress in Moscow. This work is fully reviewed in the above mentiond *Festschrift*.

Secondly, he came into contact with English scientific libraries with their open-shelves system, an experience which probably proved to be a powerful impetus in his further activities. His formal scientific education finished with his doctorate *On the Aggregation Character of the Precipitation Process of* $BaSO_4$ written in 1936 but finally accepted in 1945 at the University of Ljubljana. Although containing much of the material which was the basis of all of his later work, the fact that he did not obtain his Ph.D. at his home faculty tells us a well-known story often repeated: in a classical scientific

environment, such as Zagreb was at the time, a young unknwon man working alone in the country (at that time in Obilićevo near Kruševac in Serbia), in a military-technical institute, could not simply get away with his revolutionary concepts in colloid chemistry. He tried in Ljubljana, but for certain reasons and because of World War II, he could not receive the deserved degree until ten years later. The most important characteristics of Prof. Težak work during this period were: an uncompromising struggle for scientific truth and principles, and a strong perseverance in order to achieve all that he deeply believed in.

His final professional education in his second field of activity - the information science, was received in the USA in Bethlehem at the Lehigh University in 1967.

After several initial jobs as a technologist in various chemical-technical laboratories, he started his university career just after World War II in 1945, first as Assistant Professor at the Pharmaceutical Faculty where he was appointed Associate Professor in 1946, and from 1952. as Full Professor of Physical Chemistry at the Faculty of Science of the University of Zagreb. He was actually one of the founders of this faculty and one of the most important teachers and leaders of this institution, being the head of the Laboratory of Physical Chemistry for more than 30 years and serving terms as vice-dean and dean.

The most important achievements of that period were: the education of a great number of excellent chemists, many of them with great reputations both at home and abroad, the founding of the Central Chemical Library in Zagreb, linked with the Croatian Chemical Society, and collaboration with chemical industry. In 1950 he was one of the founders of the 'Ruđer Bošković' Institute in Zagreb, where he was the head of the Physical Chemistry Department for 20 years. He also participated in founding of the Institute for medical research of the Yugoslav Academy of Science in Zagreb.

Very early in life, he developed an approach known by everybody who got in touch with him: openness, integrity and high scientific and ethical standards. He organized or took part in almost all important endeavours at the university and in scientific community, both in Croatia and in Yugoslavia. We will list here only the most important: founding of postgraduate courses in science in 1960, including courses in librarianship, documentation and information sciences which are still unique and highly recognized in Yugoslavia, organizing of the 'Permanent International Exhibition of Publications' (ISIP), founding and leading the Referral Centre of the University of Zagreb in 1967, the International Referral Centre for Information Handling Equipment (IRCIHE) within the framework of UNISIST in 1974. It should certainly be recorded, as his pioneer work, that he activated the entire Yugoslav scientific community into organizing the system of scientific information, especially by establishing information and referral centers.

In the field of scientific publications it was due to his extraordinary efforts that the modest chemical journal *Arhiv za kemiju* was transformed into a modern periodical of high scientific quality *Croatica Chemica Acta*, which became the highest ranked Yugoslav scientific journal according to the *Science Citation Index*. In 1969 he started the journal *Informatologia Yugoslavica*, and in 1975 *Scientia Yugoslavica* and the *IRCIHE Bulletin*.

On the basis of his initiative and due to his efforts universities in Yugoslavia joined into an association, and the university journals *Sveučilišni vjesnik*, (University Gazette) and *University Today* appeared. Even the project of establishing the Interuniversity Center in Dubrovnik was achieved by means of his strong support.

From the very beginning of his scientific career he took an active part and worked intensively on organizing scientific societies. He was one of the founders of the Chemical Societies' Union of Yugoslavia, where he served as Vice-president and President, and was finally elected as life-time President h.c. While always trying to integrate and organize multidisciplinary work, he initiated the founding of the Association of Scientific Unions of Yugoslavia (ANUJ).

In this astounding opus he did not forget the transfer of knowledge to the general public. One of his contributions in this field was the organization and founding of the Technical Sciences Museum in Zagreb,

Judging from the point of view of general social interests, his work in information and communication science was the most important. In some

100 papers he explained his ideas on how to establish and develop scientific information systems, always analysing and stressing the role of small countries like Yugoslavia, in such systems. He was virtually the *spiritus movens* of the transfo mation of our lioraries into modern institutions also dealing with information and communication problems, and he was the initiator of establishing our documentation and referral centers. He regarded these institutions as node points for information sharing networks and as the most important factors of scientific development.

Characterised to his very end by youthful vigour, creativity, perserverance, firmness and at times impatience, Prof. Težak will remain in our memories as a symbol of a personality continuously searching for the scientific truth and promoting the highest ethical standards in a wide range of human activities.

T.S.

Thank you very much Prof. Deželić. Our next speaker is Neva Šilović. She is a long time associate of Prof. Težak and she will be talking about ethics in the theoretical thought of Božo Težak.

Neva ŠILOVIĆ

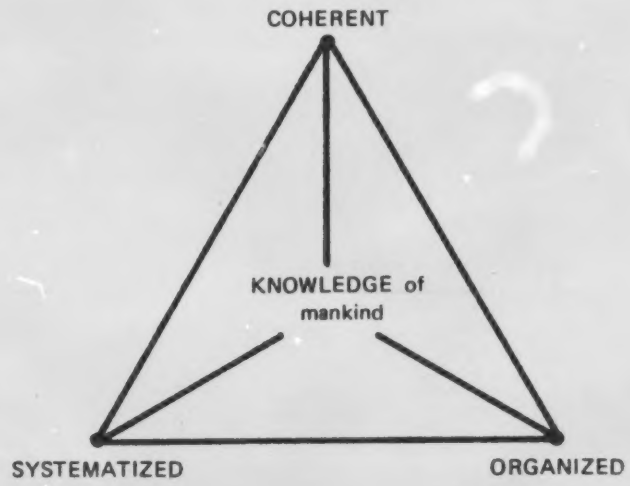
A personality such as Professor B. Težak's can be described from the various sides his prolific life provided. We have now heard of his earlier professional life and activities. I have chosen to talk about him in the light of his ethics both declared and practised during his lifetime, because to me they stand for one of the most outstanding qualities of this unique man; besides being the quality that integrated all his other activities.

As a chemist he used and valued information in his research work all his life but was also aware of the difficulties present. Yet he was 60 years old when he decided to devote most of his time and efforts to this field. The reason he gave was that no matter what you were doing within research in science and education, and those were the main fields of his work, information and communication played a crucial role. Being able to visualize the growth of new tools and new possibilities in this field, his idea was that the earlier one starts tackling the problems the better.

So he turned over a new leaf, although he did not completely give up his work at the department of physical chemistry, and in 1967 founded the Referral Centre of the University of Zagreb and in 1970, the Centre for Post-graduate Studies in Librarianship, Documentation and Information Sciences. This new field of activity gave him ample ground for expressing his views on how information should be produced, treated, transferred, used and valued.

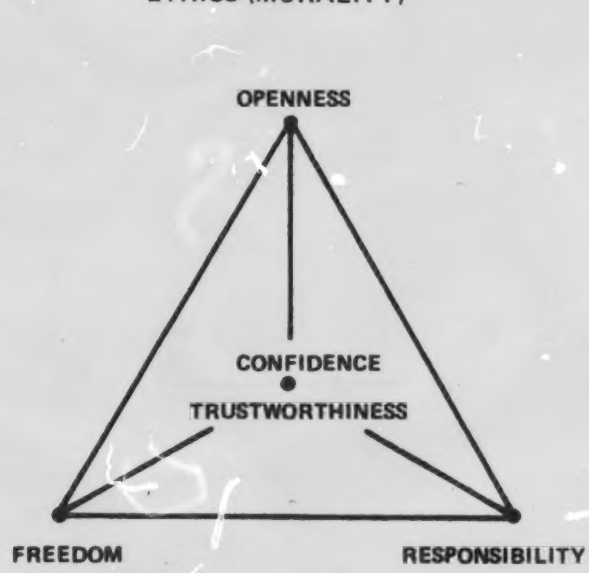
Professor Težak was particularly sensitive to scientific research, to human knowledge in general, and very often spoke and wrote about it, calling it 'the largest and the most sophisticated industry of the world'. He wrote that 'Although every research activity would be conducted by focussing the unity of thoughts, expressions and realizations, it is in defining the

GOALS of fundamental scientific researches to build a



objectives that the subtle but nevertheless crucial implications of ethics can be recognized. The field of fundamental scientific research is still *the only sphere* in which one could in the past, and one can nowadays, find the full possibility of applying the set of principles representing the practical morality of the scientific workers.'

Professor Težak defined the goals of fundamental scientific research as being the basis on which one could 'build a coherent, systematized and organized knowledge of mankind'. In order that this may be achieved in the spirit and practice of science '.. during the past 300 years there have been at work very expressive moral obligations enabling both the extensive and intensive integration of knowledge. This ethical approach is based on full acceptance of four principles:



-(*i*) openess (publicity), *i.e.* the results of research should be available to all those interested as soon as possible, with a true account of the experimental procedures and theoretical reasoning in reality there is an immanent obligation to tell the truth, the only truth and the full truth, all in accordance with the code of

-(*ii*) the freedom demanding of no one either to publish or what to publish or communicate; the application of both these principles leads to assuming

-(*iii*) the responsibility for what has been published; the application and reflection of these three principles results in

(*iv*) the trustworthiness and confidence, characterizing the scientific community which accepts the results that can be verified by everybody.'

Professor Težak wanted this bo be a model for behaviour in all spheres of human activities.

He realized at the same time, however, that different elements of information were unavoidably manifested and reflected serving often disparate goals or being misused for different purposes. 'The situation calls for coherence, co-ordination and co-operation in the sphere of information, documentation, and communication activities in spite of the existing redundancy of effect, independence and conflicting developments, uncoordinated funding, overlapping jurisdiction, and general confusion in many countries, or for that matter, in the world at large.'

Bearing this in mind he tried to resolve the confusion concerning copyright problems. Thus some years ago, in 1976 to be precise, at the General Assembly of the International Council of Scientific Unions-ICSU in Washington, and a year later at the General Assembly of International Union of Pure and Applied Chemistry - IUPAC, he demanded that instead of putting up restrictions, scientific publishers should let information be used that is, a 'fair use' of scientific material should be recognized, provided the proper citation of the information source was given. Thus, to the already existing movement of free circulation of scientists, he wanted to add a new one: the free flow of scientific information. He based this request on the statement that '.. research of fundamental character cannot be performed

without the final publishing step, and the cost of publication is usually less than 1% of the financial structure, the whole endeavour being regularly covered at the expense of wider social community, the appropriate mechanism should be found to avoid or at least restrict the commercialization of scientific publications. Keeping in mind that the scientific communities have agreed, as their primary duty, to send to the world at large their open letters announcing new knowledge, any interference in such a process of diffusion is contrary to the very nature of the societies.'

Mental preparation, moral orientation, motivation for communication. together with messages and meaning of contents, and modes of transfere - what Professor Težak called the 5-M approach - made up a conceptual framework for communication components.

When considering hardware and software, he invariably included brainware too, as the only way in which the right potentials could be enhanced. He was aware that in the sphere of knowledge and in the field of information, the interplay of various interests was present and that we had to reckon with the existence of private, public and secret sectors and all that they implied. Therefore, it seemed necessary 'to counteract the bureaucratic divisions, technocratic shematism and schizophrenic *Fachidiotismus*, by developing something like a new kind of open university structure'; He wrote this only three weeks ago in the Editorial to one of the journals where he was serving as an editor-in-chief.

Professor Težak was to us at the Referral Centre of the University of Zagreb a founder, a director, and a father figure, someone who could be approached at any time, for any personal or official reason. To his students, his associates, or anyone seeking advice or information, he was always available at all times. He set an example on how to behave according to the principles stated in his writing and was firm in pursuing the objectives he deemed right no matter what the consequences.

Professor Težak was sometimes a defender of some lost cause not because he himself necessarily believed in it, but simply in order to provide a different point of view, to provide counterbalance and make others think twice before rejecting or condemning it. He was not afraid of opponents or enemies and never sought approval at all costs. Being in so many respects ahead of his time, he stood up firmly for his beliefs knowing that the days to come would justify his ideas.

In trying to present him here I have let him talk most of the time instead of finding my own words and therefore let me conclude in this spirit with the following quotation: '...we have the uncompromising duty of acting in such a way as to protect from deterioration the only existing sphere in which we have in full function the right type of very expressive moral embracing all humanity. Acting in both a realistic and idealistic manner, we must emphasize on every occasion the significance of fundamental scientific research, and the need to incorporate its structure into any other that will help make this World a better place to live in.'

T.S.

Thank you very much Mrs. Šilović. Our next speaker is Dean Robert Hayes. He was a co-director of these three Conferences, and he will be talking about the Conferences on Universities in the World Network of Information and Communication.

Robert M. HAYES

When I first met Prof. Težak nearly ten years ago I was impressed with a mind, and a man, a personality that I would have loved to have as a father, or at least as an older brother.

A measure of his magnitude as a scientist, perhaps a trivial measure but a real one, is in the Science Citation Index. If you look at it you will see column after column of citations of his works. In my association with him I think the thing that I saw more than anything else was a belief in open communication as the essential in life. He used the sciences as a paradigm for that. He saw that open communication in the sciences was so successful and he felt that it could be equally successful in all parts of man's life. And so he wanted to project the concepts of open communication into the real functions of existing institutions. He chose the university as one institution in which there was a tradition of open communication and in which there

was a clear relationship between what he wanted to achive and the functions of the university itself. He saw that the people in the sciences and in other intellectual disciplines had either come from the university or were already part of the university. I think he saw the Referral Centre as a natural extension of the univeristy into something larger, thus making the university more than just an isolated enclave, and turning it into a part of society as a whole. And it was in that context then that he developed the idea of these conferences. They were his creation. I think that it is a courtesy to refer to anyone else as having any significat role in building and putting them together. It was his mind, his thought and his energy that went into producing them.

I will cease talking about Prof. Težak as a person and turn to the Conferences themselves, because they present a very specific achievement and I think that from my standpoint they have been of immense value. Therefore, what I would like to do is to review these three conferences in terms of their own substance. In doing so I may make reference to Prof. Težak because many of the things that were accomplished were a result of his way of approaching things. The first Colloquium and Conference were held in October of 1977. It was a remarkable experience for me and I suspect for everyone else who participated in it. He stated in his opening statements that he wanted an open, free and searching approach to the problems at hand and I have rarely experienced anything so open, free and searching as that meeting turned out to be. Everyone who came without a structure finally found it. There was no structure, and yet what grew out of the interaction among the people present was quite a remarkable organic result. I do not think it could have been accomplished by any other process. A truly remarkable thing that I attribute to Prof. Težak. There were 27 people from 6 countries participating in that programme. The programme was concerned with the roles that the university, or universities in general, could play in developing information and communication networks that were being established in the world. Prof. Težak set the stage by placing the conference within the framework of the Helsinki declaration concerning universities, sciences and culture. He also placed a strong emphasis on the role of ethics in the whole communication process. The Conference then developed a series of papers, presentations on technical issues from the field of information science, on the possible roles of universities as nodes in these networks, the process of communication through literature and technical issues concerning relevance, data bases, thesauri and the like. There were presentations on various kinds of applications. An indication of his far-reaching vision was the application of the computer in the arts as well as its application in technology. The result of that Conference was a formal statement which said that the Group had considered the developments that were occuring in information networks, recognized the trends that the future would bring and acknowledged the kinds of challenges - intellectual, administrative, financial and so on - that would have to be faced. The Group also explicitly saw the univeristy as a node, and universities in general as focal points or nodes in the development of these. It came to the conclusion that there existed the need to study, explore and debate relations between universities and growing information networks bearing two purposes in mind. One was to determine the roles that the universities could play, and second to identify what the effects of information networks would be on the university and its structure.

The second Colloquium was held a year ago, almost at this exact time in May 1979. There were 30 participants from 8 countries. There was a somewhat more formal programme. We had all gone back to our respected homes and developed material to answer some of the questions. Models of instructional programmes in the area of information handling were presented. There were papers on university networks and specific examples given as to the roles the university plays in education. There were papers identifying information problems and information needs, the philosophical basis of various needs, the role of information in developing countries and more particularly the role of information in science communication. There were papers that discussed systems, university systems, worldwide systems, management systems. There were papers on the technology: where it is heading, what are its components? The mini and micro computer revolution, the role of microforms and the mechanisms for information transfer. There were papers on network development and on some of the technical issues involved such as the allocation of resources. Papers concerning specific multimedia networks. There were papers on the technical problems involved in implementing networks. The result of that

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Conference was a definite feeling that we were making progress and that we should have at least another Conference. And we held one. We are holding it now, May 1980. In the Course that preceeded this Conference there were some 30 participants from 8 countries: Denmark, Great Britain, Hungary, Turkey, U.S.A., U.S.S.R., West Germany and Yugoslavia. The programme has been over the past week or so concerned with information, technology, information and productivity. It has considered several kinds of application of information handling in connection with problems in measurement, technology marketing, handling of experimental data and the management of enterprise. But the main focus has been in identifying what the educational requirements are. How do we tie together the diverse pieces of the information science, informatics, computer science and communications. Yesterday we had a daylong discussion in which we considered a variety of curricula and approaches within the university structure itself, dealing with education in this area. Among the points raised was the importance of interpersonal communication, a point we intend to ignore or at least put aside as we focus upon the technological aspects. A need for interpersonal communication in marketing and in public relations is also an intermediary in the whole communication process. We identified at least four types of educational needs. One is for what we identified as information and computer literacy, that is, creating an awareness and knowledge in the use of what is available and of how to use it. We identified a need for education of the managers, the people who will run the systems. We identified a need for educating the managers of technology itself. We also identified a need for the education of the person that serves as an intermediary - the information specialist. We explored a variety of issues concerning academic structures, the role of computers in teaching, the value of continuing education and we identified various strategies that seem to be successful in one way or another. That brings us to the present and with this I think I have presented a brief review of the previous Conferences.

T.S.

Thank you very much Dean Hayes. I am the next speaker. I would like to talk about some ideas that have root in Božo Težak's work and that deal with the central theme of all these Conferences as outlined by Dean Hayes.

They are the general features that we find in universities no matter where. In 1974, Yugoslavia signed an agreement with UNESCO establishing an International Referral Centre for Information Handling Equipment - IRCIHE. As it happened the Centre was then located at the Referral Centre of the Univeristy of Zagreb. It started work in 1975. From its outset it was quite evident that Prof. Težak had no intention of considering information handling equipment in its narrowest sense, in the machine sense, which is only a part of it. We started with almost the classic systems approach thus trying to identify the problems which are associated with information handling equipment in the developing world. I wish to underline particularly that the idea was to relate that Centre to the developing world. He identified two fundamental problems, and they are interrelated. One is the failure of imported technologies, a phenomenon that became evident during the late 60's and the early 70's in a large number of developing countries. Subsequent to the failure of technology is the failure of the organization associated with that technology. In that sense he was in the forefront of a worldwide discussion on the models, strategies, principles, techniques, whatever you want to call them, applied in relation to social and economic development. Eventually, in the mid 50's the notion of appropriate technology as a response to technological failures that occured in less developed countries resulted out of this discussion. Let me tell you very briefly what the failures were: Above all it seems to the analyst that one of the failures of imported technologies, particularly turn-key technologies (install, give the key, turn it on) was that it was not integrated within the structure of universities, of society itself, or of the economy. As such, because of non-integration, this technology, particularly factories, became known as sick industries. They drain more than they contribute. The second failure is equally sad. Generally, the imported technology was above the level of the available work force. Thus it became inoperable very quickly. This was true of universities as well as of very simple industries. Prof. Težak wrote about idle equipment. Equipment that nobody even knows to turn on or even less how to repair. Equipment that has been lying around unused for a considerable amount of time. You can see thus the unproductive approach of technology importation which is above the level. The third failure of such technology was that it tends to use the capacities that are in short supply rather than the capacities that are in large supply in most countries. In other

words these technologies are high capital intensive and require high human expertise which are both generally in short supply. They are also not labour intensive which is usually in large supply in most of the countries.

Thus, the idea that what we need is an approach to appropriate technology surfaced on the international level. What this idea failed to do was something that Professor Težak was very much aware of. Internationally there is very little discussion on the very connected issue of appropriate technology and the appropriate organization for that technology. It is not enough to have a labour force that knows how and to use it intensively if one wants to integrate technology. You have to have associated organization, or to use the American term management. Thus we have not only an appropriate technology problem but also a management problem. So his answer was that it is no use to provide referral on who has what kind of a computer, although he did not say we would not do it at all. In addition he said that we should be very much concerned with the level at which this equipment, these computers, telecommunications, micrographic equipment and so forth would be appropriate and most usefully used within a given framework.

I guess that he must have searched very thoroughly for the appropriate place - to use the word appropriate again - in which to begin the resolution of both managerial and organizational problems and the level of the people which he considered to be of crucial importance. It came as no surprise that he hit upon the answer - universities should be the places. In my mind this is a logical answer. However, we are all biased. We work at the university and we think that universities can do a lot of things which they are possibly not equipped to do. And in this I think lies his search within the framework of these Conferences and in other ways. How can we equip universities to produce the kind of people that will do two things: manage this whole organizational structure which relates to information (that means information manager) on one hand and apply this technology in an effective and efficient way on the other. Universities are the right places to begin. And what we have in developing countries is a phenomenon which may not surprise you at all. This is the growth of universities in developing countries which by far exceeds the combined growth of universities in all developed countries. I do not have complete data but I have just completed a study in which I used the data for medical schools. The World Health Organization issues a world directory of medical schools. The latest directory came out about 4 or 5 months ago. It presents a comparative study on what has happened during the last twenty five years or more in medical schools throughout the world. The latest directory lists 102 Member Countries of WHO that have medical schools. Out of these 102 countries, 79 are developing countries. No European country was counted as a developing country in that sense. There are some 1200, or little less than that, medical schools in the world. Of those 1200, 53% are now in the developing world. Ten years ago there were less than 40%. Twenty years ago there were less than 20% of medical schools in developing countries. Of the close to 1200 medical schools, 600 are in developing countries. 200 were added between 1970 and 1977, and 200 were added in the 60's. They more than doubled during that period of time. It is clear that these universities - medical schools are all parts of universities - have problems. The problems are more acute in less developed countries. They are even more acute in new fields such as computer science and information science, more so than in the field of medicine for instance. The attempt to do something about these problems has many aspects and levels. We can talk about the level that deals with physical resources. No matter what they cover you always come across huge problems. We can talk about economic resources, and there are huge problems there also. We can talk about human resources and there we have the biggest problems. Educating the educators seems to be the most acute problem of all in these developing universities. To me this seems to be the fundamental general feature in terms of the problem in the less developed world and not only there. What Težak tried to do was to define this general feature through what we have already heard - knowledge. He avoided the idea of administrations, the idea of regulations, of governments and so on. And in this respect he was right. Science is universal. Knowledge is universal. If we improve knowledge and the dissemination of knowledge we will improve the university as well. He established certain characteristics of that knowledge and certain ethical and moral concerns, connected with knowledge, as defined by Neva Šilović. I am not going to repeat them.

We should now I think, at these Conferences and other similar ones, try to define the structure of knowledge, the effective way in which this

knowledge may be communicated, be it through print media, computer media or through educational efforts. There is another effect happening at universities, a very positive effect to my mind. There is a growing internationalization of universities all over. There is a very large mingling at the universities of the developed world of students from all over the world. I do not have data for Europe, but I can give you some data for the U.S. We had over 200,000 students from abroad. An overwhelming number of these from the developing world. In some fields such as engineering, close to 40 to 50% of degrees are given to students from developing countries. This has had a remarkable effect on US education as well as an effect on the international scene. We have seen this repeated at many universities throughout the world, including Yugoslavia, which has an increasing number of students from abroad. Still universities were always international. The very idea is international, but they were never so international physically as they are now. And possibly it is this second aspect that we have not mentiond at these Conferences and that is this growing internationalization of universities, which will provide more and more bonds between us.

I wish to conclude with a few thoughts. We generally accuse the universities as having been or being non-flexible. And nobody more than Prof. Težak accused them of inflexibility. This is a bad thing. However, this is also a good thing. Because our inflexibility is sometimes a very good defence for the type of ethical and moral principles of openness, of free communication of knowledge for mankind that Prof. Težak greatly supported. After all, the role of universities is to create knowledge, to disseminate knowledge and to educate people in that particular knowledge. We realize that there is a great deal left undone in identifying more specific common features among universities. We realize that the surface has only just been scratched in this particular field. There is so much more to do, so much more to explore. However, I think that the initial ploughing done by Božo Težak is in the right direction. Thank you very much.

INTER-UNIVERSITY CENTRE of postgraduate studies
DUBROVNIK **1979/1980**

Universities in World Network of Information and Communication III

Course: 13 — 19 May, 1980

Course is followed by Conference: 20-23 May

PROGRAMME:

Who should attend: professors, librarians, university managers, decision and policy makers and other professionals likely to be involved in the modernization of university through the use of computer based/oriented lectures, information retrieval systems and networks. Students interested in modern university structure and functions are also invited.

Objective: on completion of this course the participant will have a thorough understanding of the major changes in education and professional life due to the advent of new technology in general, and of microcomputers and information retrieval/processing systems in particular.

Topics to be covered: the course is composed of a series of state-of-the art lectures, providing an overview and projecting into the 1980s. The lectures will focus on three problem areas: INFORMATION TECHNOLOGY, TRADITIONAL AND MODERN ORGANIZATIONAL STRUCTURES and EDUCATIONAL TECHNOLOGY. The following are preliminary lecture titles:

— From microcomputers to supercomputers in the 1980s
— Computer science now and in the 1980s. What, how and whom to teach?
— Software today and in the 1980s
— Existing and future information retrieval systems
— Optimal organization structure integrating information, technologies and goals
— Impact of new theories on information processing and organizational structures
— Traditional information and communication infrastructures
— Library and information services now and in the 1980s
— Management and information processing now and in the 1980s. What, how and whom to teach?
— Teaching aids and computer aided instruction
— Documentation in education
— International standardization of modular university programmes

Resource persons:

H. J. A. Goodman (Calgary), **R. M. Hayes** (Los Angeles), **J. Kidd** (College Park, Maryland), **S. Prohorov** (Kuibyshev), **K. Samuelson** (Stockholm), **T. Saračević** (Cleveland), **B. Težak** (Zagreb), **G. Thuro** (Hamburg), and others.

Directors:

Branko Souček (Zagreb) and **Ferenc Vajda** (Budapest).

Work schedule:

The course will consist of lectures and seminars, six hours per day, five days per week. There will be two lectures in the morning, followed by discussions organized by resource persons. In the afternoon there will be seminars organized by participants who are encouraged to bring material they wish to present.

The working language will be English and a good working knowledge of the language will be assumed.
There will be no examinations, but participants are expected to write a paper individually or collectively (e. g. by rewriting their seminar presentation) either during or shortly after the course. This is a condition for receiving a Certificate.

The course is held at a postgraduate level, but is also open to particularly motivated students who have not yet reached that stage in their studies.

General information:

a. Those intereseted in participating in the course should write to the Secretariat of the IUC as soon as possible, at the latest two weeks before the beginning of the course. (The IUC reserves the right to cancel the course if there are too few participants; applicants will be informed immediately).

b. There are special application forms available at the Secretariat (which will also give additional information) and at Member Universities. Requests for participation can also be made without application form provided the following information is given: name and surname; place and date of birth; present nationality; academic qualifications (degrees and other qualifications, institution, time of acquisition) or recommendation by a professor or expert in the field of the course; present professional activity and mailing address.

c. Participants will pay their own expenses for accommodation in Dubrovnik (available at hotels with three meals and room for about $ 12—15 daily), and a course fee of 200 Din. ($ 11). For students from IUC member universities special scholarships for IUC study may be available from their universities.

d. Information regarding accommodation, travel etc. can be obtained from the Secretariat of the IUC in Dubrovnik at the following address:

INTER-UNIVERSITY CENTRE of postgraduate studies
Frana Bulića 4
YU - 50 000 DUBROVNIK **Telephone (050) 28-666**
YUGOSLAVIA **Telegraphic address: INTERUNIVERSITY**

INTER-UNIVERSITY CENTRE of postgraduate studies
DUBROVNIK **1979 1980**

Universities in World Network of Information and Communication III

Conference: 20 - 23 May, 1980

Conference is preceded by Course 13 - 19 May

Programme:

This third conference, organized in association with the International Referral Centre for Information Handling Equipment (IRCIHE), continues the study, exploration and debate of relations between universities and world information systems and communication networks started by its predecessors held at the IUC in 1977 and 1979. In view of the need to establish a sustainable system to handle recent developments in information and communication, organization of universities into the focal points of such a system has been proposed.

The major motivation for promoting universities as focal points in the world network of information and communication arises from the fact that universities are traditionally characterized by interaction of different modes (scholarship, research, education) and fields (natural sciences, social sciences, arts and humanities) of human activity, both fundamental and applied, and by disinterest in economic and political advantages and by commitment to free exchange of ideas and of information.

The major goal is to define the organizational structure that would ensure the return of the university into the mainstream of scientific, technological and social development. This can be done only by striking the right balance in opening the university to other social structures so as to ensure its flexibility on the one hand, and preserve its identity on the other. In this light special attention should be given to the relationship between praxis and theory within university programmes.

The task on hand is to examine the feasibility of universities as focal points in the world of information and communication. In doing this the conference will deal with the main characteristics and problem areas concerning UNIVERSITIES, INFORMATION RESOURCES and INFORMATION NETWORKS. Special attention will be devoted to international concerns in these matters, particularly as expressed through efforts of UNESCO (UNISIST). Concrete suggestions for the organization of an International Forum that would deal with the related problems on a permanent basis, will be considered.

Call for papers: The International Programme Committee welcomes your prospective papers. Please send three copies of a 200 word abstract to IRCIHE, Trg maršala Tita 3, 41 000 Zagreb, Yugoslavia, by Feb. 15, 1980. If necessary, further information can be obtained on request.

Resource persons:

F. W. Baker (Paris), **V. Bonačić** (Zagreb), **A. Debons** (Pittsburgh), **E. Garfield** (Philadelphia), **H. J. A. Goodman** (Calgary), **B. Justin** (Ljubljana), **J. Kidd** (College Park Maryland), **I. Marin** (Pittsburgh), **S. Prohorov** (Kuibyshev), **K. Samuelson** (Stockholm), **B. Souček** (Zagreb), **J. Spanring** (Ljubljana), **V. Stojanović** (Beograd), **D. Skiljan** (Zagreb), **G. Thuro** (Hamburg), **S. Turk** (Zagreb), **F. Vajda** (Budapest), **F. Vreg** (Ljubljana), and others.

Directors:

Robert M. Hayes (Los Angeles), **Tefko Saračević** (Cleveland) and **Boško Težak** (Zagreb).

General Information:

a Participants will pay their own expenses for accommodation in Dubrovnik (available at hotels with three meals and room for about $ 12 — 15 daily), and a course fee of 200 Din. ($ 11). For students from IUC member universities special scholarships for IUC study may be available from their universities.

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YUGOSLAVIA **Telegraphic address: INTERUNIVERSITY**

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PANEL DISCUSSION ON

'EDUCATION AND TRAINING IN INFORMATION AND COMMUNICATION'

IRCIHE Bull. 6 (1-2) 13-20 (1980)

Panel discussion on

EDUCATION AND TRAINING IN INFORMATION AND COMMUNICATION

Members of the Panel:

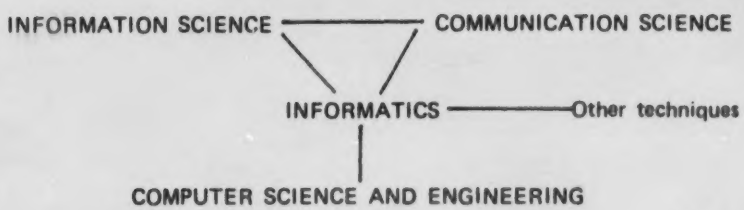
D. Anderson (Denton, USA), Gj. Deželić (Zagreb, Yugoslavia), R.M. Hayes (Los Angeles, USA), B. László (Zagreb, Yugoslavia), T. Saračević (Cleveland, USA), B. Souček (Zagreb, Yugoslavia), V. Srića (Zagreb, Yugoslavia), V. Šilović (Zagreb, Yugoslavia), G. Thuro (Hamburg, W. Germany), S. Turk (Zagreb, Yugoslavia), and F. Vajda (Budapest, Hungary).

Chairman: Stanko TURK

OPENING ADDRESS

Stanko TURK: GENERAL FRAMEWORK

The topic to be discussed is education in the fields of information and communication. In the context of this series of three conferences on Universities in World Network of Information and Communication (Oct., 1977, May, 1979, and May, 1980) special attention will be given to what universities can contribute in this matter. Drawing upon the Conference title and programme two areas of major concern can be distinguished: information science and communication science. Further area that is related to these is informatics. There is no general agreement as to what informatics is, but we can assume that it deals with different methods, both conventional and nonconventional, of information processing. Since the present state of information processing and of the relevant communication activities require extensive use of computers, all kinds of computers and computer techniques have to be taken into consideration. We can recognize four interrelated areas:



in whose context at least the following issues should be examined.

- What is a common denominator for information and communication sciences? Does it exist?

- What knowledge ought to be shared between these two fields?
- Is there a need for the exchange of courses in these two fields?
- Does there exist something like a core curriculum for information and communication sciences?
- What are the possibilities of teaching informatics to the students of information and communication sciences?
- What level of the computer science and computer engineering education is needed?
- What is the role of libraries and referral centres in the education network?
- What is the role of information and communication sciences in relation to other fields? What kind of interrelations should be established?
- What job opportunities can be foreseen for the information and communication science graduates? Is there a need for the professionals trained in informatics?

The panel is so composed that the members of the panel cover wide areas within the general framework provided above. They all have an extensive experience in the education and education planning. In addition to the formal education leading to different degrees it is very important also to consider informal types of education and training, and the continuing education and after-the-hours education in particular.

There does not exist only one educational model. The education in different schools and in different countries differs in many details, but there certainly are some common features. Among these the most outstanding are multidisciplinary and interdisciplinary approaches.

Stanko TURK: DEFINITION OF PROBLEMS

1. The notion of the information is not well defined and can be understood in various ways,
2. Data are carriers of information, so the information processing leads to the data processings,
3. There is, generally speaking, no common curriculum to be shared, best there exists common knowledge to be shared,
4. There is an example of information as a 'minor', so connecting different areas, and introducing informatics methods to the 'major' areas,
5. Communication and information principles should also be taught in engineering, etc.,
6. Informatics is needed in different fields, even in such a traditional areas as an example in medicine,
7. Informatics is a very broad activity which should be interwoven with different major scientific or application area. Informatics has to serve as technique for information preparation.
8. The inter personal communication is of extreme importance, so education should enable it. The human relations cannot be replaced by a computer.
9. Public relations are an important aspect of communication. A good feedback must exist.
10. It is recognized the need to educate:
    - information and computer literate people
    - runners of information systems
    - runners of information technology
    - information specialist in different fields.
11. Continuing education may be of a great benefit in general education for information services users, particularly if it is not centralized.
12. Decentralized network of computers can greatly contribute to the quality of the services, both to the number crunching users and to information handling users.

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WRITTEN CONTRIBUTIONS*

Dorothy J. ANDERSON:

EDUCATION FOR LIBRARY AND INFORMATION PROFESSIONALS - WITH EMPHASIS ON USER ACCEPTANCE

INTRODUCTION

A major problem confronting the field of librarianship, in the U.S., is the shift from a service orientation to an emphasis on speed and economy. The average library user is bewildered by the new technologies being introduced into the familiar library environment.

Librarians themselves, traditionally humanistic in outlook and in educational background, are often reluctant to acquire the skills needed to handle information available only through distant data bases and complex machinery.

Since both information science and management science have become generally accepted as essential to education for librarianship in the U.S., the focus of this brief paper will be the increasingly neglected area of direct service to the USER.

RATIONALE

Theoretically, both information science and management science when applied to the library environment, are designed to organize efficient use of human and material resources for the immediate satisfaction of the end user.

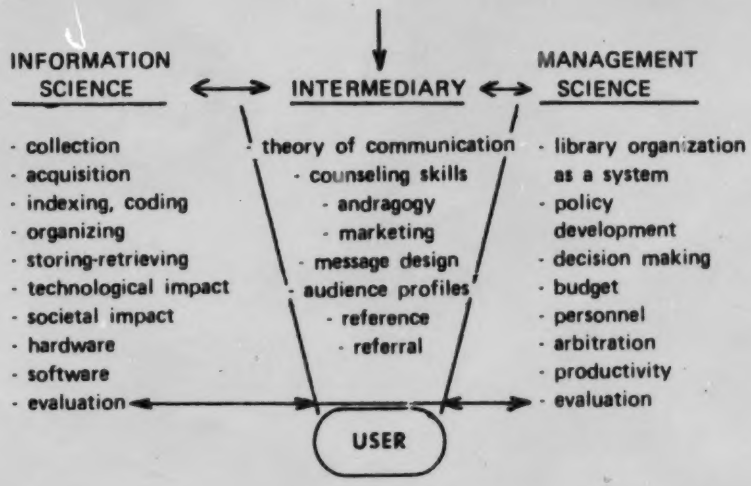
Both groups of new-breed 'scientists', however, tend to become engrossed in the problems and challenges of their non internal systems and processes without due regard for the impact of these (often incompatible) systems on the user as human being with varying psychological and intellectual needs.

* Other oral contributions and discussion at the Panel had not been recorded.

It is possible, then, that a specific series of courses might be offered to the librarian who chooses to be the mediator, or intermediary, between the library, as an institution which can provide access to information through sophisticated technology, and the individual user or seeker of information.

CONCEPTUALIZATION

In terms of educating this 'service professional' or mediator, the focus should be on the acquisition of skills in interpersonal communication, in addition to a basic knowledge of both information science and management.



Such a library service professional could provide accurate feedback on user needs and attitude to both information technologists and managers in order to refine the systems for the sake of user satisfaction.

CONCLUSION

There is nothing new about the idea of an interpreter or information mediator, and nothing new about the concern for the user which is expressed, superficially, here.

There are, however, new data being gathered now which suggest that resistance to technology is a factor which may continue to complicate easy access to information unless we specifically train some of our librarians to understand the human dimensions of the information transfer process.

The ability to relate to the user may be as important as the ability to collect, store and retrieve information - if an acceptable degree of precision and relevance is to be realized.

Charles BUKOWSKI:

THE BEHAVIORAL SCIENCES AND THE LIMITS OF INFORMATION SYSTEMS

The growth and development of information systems during the past two decades has been, to say at least, spectacular. Innovative developments in the area of information systems have appeared so frequently during this period that they are more properly considered the rule rather than the exception. Such developments have, in turn, had profound impacts on both the natural and behavioral sciences. Vastly improved capabilities in collecting, storing, manipulating, and retrieving information have extended the potential for development in both areas of science to remarkable dimensions. While one can little dispute this notion, it does appear necessary to clarify at least one portion of it. This relates to the impact of the development of information systems on the behavioral sciences. This development has undoubtedly widened the potential for the growth of knowledge in this area, but, unlike the natural sciences, the growth of information systems capabilities does not always trigger a related flourishing in the behavioral sciences.

The primary reason for the above argument is that phenomena studied in the behavioral sciences are distinctly different from phenomena studied in the natural sciences. Behavioral phenomena differs from natural phenomena in that they are intentional. Such phenomena express, in some manner, the beliefs and ideas of the actor. This type of phenomena is referred to as social phenomenon.

Because social actions are intentional they are said to contain a meaningful character, and that in order to fully understand that action, its meaningful character must somehow be exposed. This is done through analyzing that action in terms of the intentions of the actor and the conventions of the society in which that actor exists. By virtue of this knowledge, it is possible to interpret a social action and thus determine its social significance.

The problem of intentions and meanings do not exist for the natural scientist. New data can be immediately incorporated into the existing body of knowledge without the necessity for interpretation.

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The intentional character of social phenomena necessitates a second difference with the method of study in the natural sciences in that explanation is achieved via different means in the behavioral sciences. Because social behavior is intentional it is necessary for the scientist to understand or interpret the significance of an action on an individual basis. Thus when a social scientist seeks to explain a social phenomenon, he is concerned only with interpreting that particular phenomenon in terms of the actor's intentions and the social conventions to which that actor conforms. The social scientist has no need to develop generalizations in order to explain a particular action. And, in fact, such generalizations themselves cannot be constructed until a number of individual actions have been interpreted and related to one another.

This contrasts with the physical sciences in which explanation is considered impossible without the existence of generalizations. Individual observations of natural phenomena are, in the natural sciences, considered nothing more than coincidental occurrences until they can be logically related to one another through the deductive use of generalizations or, in more technical terms, covering laws.

Given this conception of the behavioral sciences, it becomes evident that the process of interpretation assumes an intermediate role between the gathering of new data and its incorporation into a body of knowledge. Before the incorporation of facts into knowledge can take place in the behavioral sciences, these facts must be interpreted - they must be analysed for the ideas and beliefs they contain. This task is carried out in two ways: first, through the use of the practical syllogism, and second, through the use of the hermeneutic circle.

The practical syllogism is generally used to derive the intentions of the actor whose behavior is under observation . It involves the use of 'because of' or 'intends to' type statements to explain why a particular action was performed. For example, when a person raises his hand during the voting process of a town meeting, we can explain his action by stating that he raised his hand because he intended to demonstrate his opposition to a proposed tax increase. In this way the individuals' actions are explained, and the explanation is formed without the use of generalizations - as would be the case in the physical sciences. In addition, this example demonstrates how raw data (the raising of the hand) requires interpretation (he intended to show his opposition to a tax increase), before it can be incorporated into an existing body of knowledge regarding this individual's behavior in certain social situations.

The hermeneutic circle is a tool used to determine the conventions of the society in which the individual exists. The process for this method of explanation involves the consideration of specific actions within society as well as general conceptions of the society as a whole. By 'tacking' between the specific and the general, it becomes possible to derive social conventions. This process is quite similar to literary interpretation in which specific instances are used to construct a general meaning of a text, and, in turn, the general orientation of that text can be used to derive the meaning of specific instances encountered in the text. By constantly moving back and forth between the specific and the general, it is possible to build an accurate picture of the general orientation of the text as well as shed light on more specific cases. Thus, in our example, the raising of the individual's hand cannot be interpreted unless one has an understanding of the more general conception of voting or the social, political, and philosophical beliefs contained in the related concepts of democracy and freedom of expression. However, the understanding of these beliefs also depend, in turn, upon the understanding of specific instances of voting. The use of the hermeneutic circle, then, enables the social scientist to develop an understanding of the necessary social conventions related to the act of voting.

One other assumption is crucial to the acceptance of the 'interpretative' or phenomenological approach to social behavior, and it involves an understanding of the interpretative concept of 'action.' In the realm of the interpretative approach, the term action involves two distinct ideas. First, it involves the physical movement itself (i.e. the raising of the subject's hand). Second, action involves the specific intention behind that action (i.e. the intention of the subject to express his opinion regarding a tax increase). These two ideas are inseparable in the term 'action.' In other words, the interpretative approach holds that the observation of the subject raising his hand simultaneously involves the interpretation of the meaning of that action. It is impossible to separate the two - observation and interpretation take place together. This assumption is the key to the interpretative

approach. By arguing that movement and meaning are permanently linked, it becomes impossible to study social action in any other manner than the interpretative approach.

The above argument is also the primary contention of this essay: that the behavioral sciences are fundamentally different from the natural sciences. This difference exists both in the nature of the phenomena studied and the method of explanation utilized. The implication of this difference on the information sciences is clear: that advancements in information systems and data processing techniques do not have as broad implications for the behavioral sciences as they do for the natural sciences. While improved information systems can improve the quantity and quality of the data available to social scientists, it cannot, by itself, expand the body of knowledge available to the behavioral sciences field.

Sergei PROHOROV:

SOME QUESTIONS ABOUT TRAINING SPECIALISTS IN TECHNICAL CYBERNETICS

The rapid development of science and technology has intensified the need for preparing specialist of higher qualification in all fields, particularly in those which use modern information and computer technology. Consequently universities and institutes everywhere are striving to improve the traditional methods of education and to develop new ones.

The traditional techniques do not always produce the desired results. It is necessary to accustom students to solving scientific and engineering problems themselves as soon as possible. There are various methods which are used in institutes in the USSR, the most important of which are: engagement in a student science society, employment in a student construction bureau, in a student research institute, in base institutes, in a normal construction bureau, in industry, etc. The results show that such students are better able to formulate and solve scientific and engineering problems, take part in different meetings, conferences, exhibitions, present scientific papers, and so on. As a rule these students require less adaptation time in industry and research institutes and are thus more immediately productive.

The next step for training specialists is the postgraduate course, normally three years. Generally, the young specialist must work at least two years in a research institute or in industry. However, on occasion he may receive immediately permission from the Scientific Council to study as a postgraduate student, if he has written scientific papers and shows talent for scientific work.

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Postgraduate students work on their thesis according to their own plans, but in addition attend common lectures in philosophy, foreign languages, pedagogy, and so on. At the end of the third year they have postgraduate exams and defend their thesis for the "kandidat" degree.

The requirements for this degree are, stated simply:

1) an authentic contribution to science;
2) practical application of this contribution.

All theses have to be justified in terms of practical results, which will be incorporated into industry and produce real economic benefits.

The final step is the "doctorate" which exists now only formally. As a rule, a "Kandidat of science" is working on his doctoral thesis in parallel with his primary activity, but he may receive a maximum of two years' leave of absence to complete and defend this thesis.

Requirements for the doctoral thesis are more strict than those for the "kandidat", both concerning pure scientific discovery, as well as the practical application of such. As a rule, the thesis presents some new and original aspects of the field of investigation. There are differences betweent the procedure for preparing the defense and the defense itself.

All theses have to be confirmed at the Higher Certification Council ("VAK") in Moscow. The existing special scientific councils in various fields of science were formed after the reorganisation of "VAK" in 1975. That year the thesis requirements, defense procedures, and specialty descriptions were defined.

However, there are certain fields of science and technology where it is very difficult to determine the boundary between the various branches. Technical cybernetics and its branches belongs to this type of integral science.

Currently, specialists in the fields of technical cybernetics and information technology are being prepared in different universities and institutes - technical, economical, cultural and such. There are various types of narrower specialties that deal with information technology, for example: information measurement technology, information networks and systems, data bases, etc.

It is obviously not possible to prepare specialists capable of solving all problems in information technology. It is more important to train specialists in a precise subfield, who can nevertheless understand the main questions in technical cybernetics and find a common language with specialists in adjacent fields.

CLOSING COMMENTS

Robert M. HAYES: SUMMARY

This panel was concerned with combinations of educational programs in information sciences, informatics, computer science, communication science, and other related disciplines.

The discussion presented a variety of approaches to curricula, most of them based on treating information sicence as a 'minor' in other, substantive areas (like medicine, management, science and technology, librarianship, etc.).

The importance of 'inter-personal communications' was emphased, especially with respect to the need for intermediaries between systems and the users of them.

Marketing a public relations were identified as critical functions, for which intermediaries play an important role.

The needs for 'continuing education' were discussed.

Four kinds of educational needs were identified:

(1) For the users, to provide computer and information 'literacy' - a knowledge sufficient to be able to use information systems.

(2) Managers ('runners') of information systems

(3) Managers ('runners') of the technology

(4) Computer and informations specialists - the intermediaries.

A typology of educational (curricular) strategies was presented:

A. Subject	B. Departmental	C. Service bureau
1. Single-department	1. 'New wine - old bottles'	1. Computer facilities
2. Multi-department	2. Stratified	2. Information facilities
3. Graduate division	3. Student exchange	3. Departments

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CONFERENCE PAPERS

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INFORMATION AND PRODUCTIVITY

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The Information Economy

Fritz Machlup, in his book, *The Production and Distribution of Knowledge in the United States* (1962), pointed out that as an economy develops and as society becomes more complex, the efficient organization of production or government seems to require an increasing proportion of labor going toward 'knowledge' production in contrast to physical production. This shift has occurred in all sectors of our economic and social structure.

Machlup also suggested the hypothesis that an increase in the ratio of knowledge producing labor to physical labor is strongly associated with the increase in productivity and thus with the rate of economic growth. He made a first attempt to measure the production and distribution of knowledge. In doing so, he grouped thirty industries into five major classes' (1) education, (2) research and development, (3) media and communications, (4) information machines, and (5) information services. He estimated that, for the year 1958, 29% of the gross national product was spent for knowledge, and that 30% of the labor force was employed in the knowledge sector of the economy. Furthermore, the knowledge industries expanded at double the rate of the national economy as a whole during the period 1947-1958.

Jacob Marschak, an eminent economist and a member of the UCLA faculty until his death a few years ago, calculated, in 1968, that the knowledge - industries would approach 40% of the GNP in the 70's.

The context has now been most completely and excellently presented in a more recent study, published in 1977, called *The Information Economy*. It was carried out by Dr. Marc Uri Porat, under the auspices of the Office of Telecommunications of the Department of Commerce, and was an outgrowth of Dr. Porat's doctoral dissertation, done under the direction of Wassily Leontieff. That study is of vital importance in itself, and while one may quarrel with specifics -- such as the definitions of the information industries and the subdivision of the information sectors of the economy -- the overall import of the study transcends any such nitpicking about details. And that import is precisely that information is an economic force that pervades our society, a force that has gone largely unrecognized, except in the advertising puffs and the solemn words of the information professionals about 'how important information is' - to decision-making or whatever other pet application the information professional may have in mind. Porat has clearly demonstrated that information is a vital factor in our society and our national economy. What makes it even more important is the implication by Porat that it is not necessarily an unalloyed benefit. There may be clear reasons for regarding at least some aspects of the information revolution as counter-productive, in both senses of that term.

Let me start by presenting Porat's definition of the 'information economy' - those industries and parts of industries that are involved in the accumulation, processing, and distribution of information. Fig. 1 presents the typology for those industries that Porat assigns to the 'primary information sector'. To give some examples for each:

TYPOLOGY OF PRIMARY INFORMATION SECTOR INDUSTRIES

KNOWLEDGE PRODUDUCTION AND INVENTIVE INDUSTRIES
INFORMATION DISTRIBUTION AND COMMUNICATIONS INDUSTRIES
RISK MANAGEMENT
SEARCH AND COORDINATION INDUSTRIES
INFORMATION PROCESSING AND TRANSMISSION SERVICES
INFORMATION GOODS INDUSTRIES
SELECTED GOVERNMENT ACTIVITIES
SUPPORT FACILITIES

Figure 1

Knowledge Production and Inventive Industries

Research and Development Companies
- Information Services

Information Distribution and Communication Industries

- Education
- Public information services
- Regulated communication media (TV, radio...)
- Unregulated communications media (publishing)

Risk Management

- Insurance companies (at least, in part)
- Finance industries (again, at least in part)
- Speculative brokers

Search and Coordination Industries

- Non-speculative brokerage industries
- Advertising industries
- Non-market coordinating institutions

Information Processing and Transmission Services

- Non-electronic based processing (typesetting)
- Electronic based processing
- Telecommunications infrastructure

Information Goods Industries

- Non-electronic consumption or intermediate goods (envelopes, ink)
  Non-electronic investment goods (paper machines)
- Electronic consumption or intermediate goods (phonograph records)
- Electronic investment goods (computers)

Selected Government Activities

- Primary Information services of federal government
- Postal service
- State and local education

Support Facilities

- Information industry structures
  Information industry office furnishings

It is worth quoting Porat directly:

> 'The end product of all information services markets is knowledge. An information market enables the consumer to know something that was not known beforehand; to exchange a symbolic experience; to learn or re-learn something; to change perceptic or cognition; to expand one's range of options; to exercise rational choice; to evaluate decisions; to control a process; to communicate an ideal, a fact, or an opinion. An information market may sell topical knowledge with a very short life; it may exchange longlasting knowledge. It may involve a completely specialized or unique configuration of knowledge, useful only to one person in one situation, or it may be public knowledge generally available to all simultaneously and generally useful in many contexts. It could be extremely costly to produce, or it may involve very simple processing and transmission approaching zero marginal cost. Information could be a lengthy process spanning a whole lifetime, or it could be a burst of data occuring in a millionth of a second'.

That's a very broad definition, one that I am comfortable with, at least as a starting point, but one that has been the basis of some criticism of Porat's results, the view being that it is much too broad to be useful. Certainly something that puts together, as Porat's definition does, the telephone system, the nation's banks and other financial institutions, the nation's educational system at all levels, with all of publishing as well as that part of the entertainment business that includes TV, films, music, art, *etc.*, is encompassing by its very definition a major segment of society. Just how large, we'll see in a moment, but before doing so, let's see what's not included in the primary information industries.

Clearly the food industry - from basic agriculture to food processing,

distribution, transportation, service, and related construction - is not. Clearly primary industry - from mining or other means of producing raw materials through the production of machine tools and finished products, to the distribution, sale, and service of them - is not included. Clearly a major portion of the traditional service industries - personal services, maintenance and repair - is not.

But even in the industries not included in the primary information sector there are significant amounts of internal information activities - various kinds of accounting systems, data processing systems, and management information systems. As we are all well aware, these have burgeoned within the past two decades, but they have always been more or less present. Porat defines such activities as constituting the 'secondary information sector.' Such activities, within firms rather than between them, as Porat defines them include: electronic data processing, letter typing services, duplicating services, printing services, internal research and development, management information services, legal services, internal libraries.

In arriving at this division between primary and secondary information activities, Porat makes some assignments - special libraries in industrial corporations to the secondary information sector, for example - that in the broadest sense one would want to include among 'information services,' and, on the other hand others are included among the information industries - ink and paper, for example - that might more properly be treated as non-information industries. But in the overall, the assignments are useful and in this talk I will accept them as they are.

Given those definitions, Porat arrives at a conclusion which, while not very surprising, has rather major implications. Specifically, he finds that today the two information sector components - the primary and the secondary - taken together, accounted for nearly 50% of the nation's labor force in 1967 (the year to which most of his data relates). As I say, that result may not be very surprising, since the definitions of the two components are such as to incorporate a rather broad segment of our working force. Two things make the implications important, however. First is the sheer magnitude of the percentage. When almost 50% of the labor force is involved in occupational work that heretofore have been statistically buried in the traditional sectors of the economy - primarily in 'services' and to some extent in 'industry' - we must feel that there has been inadequate attention given to the significance of this fact. But second, and in the long run even more significant, is the rate of growth in the information conponents over the last 100 years or so.

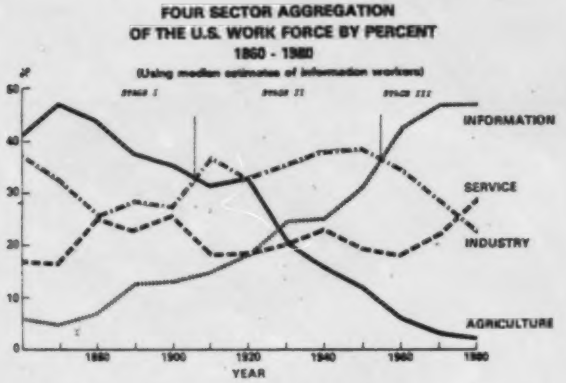

Figure 2

As Fig. 2 shows, the percentage of the work force engaged in agriculture has steadily declined during that period of .ime; that engaged in industry has shown steady growth (until about twenty years ago when there began a rather dramatic decline). In previous economic analysis, the services sector has been seen as the area of growth, the sector absorbing an increasing proportion of the labor force. Porat's analysis implies that in fact the non-information services sector has maintained a relatively constant role in the economy - some ups and downs, but in the overall pretty much at the level of 20% of the work force.

The dramatic increase is in the information sectors. They grew from less than 5% of the labor force 120 years ago to nearly 50% in 1967 - perhaps

even more today. In fact, if we fit an exponential growth curve to the information sector, we see a very close match with a growth rate on the order of 25% per decade. And if it is recognized that this picture shows the relative growth rate in the face of an exponentially growing population, the magnitude in growth in absolute terms becomes even more spectular. Thus, the labor force committed to information services of one kind or another has increased at a yearly rate of nearly 4%!! That's a doubling every twenty years, a rate two-and-a-half that of the population as a whole.

Of course, given the range of occupations included in Porat's definitions, it is clear that they will differ among themselves in their relative rates of growth. Some components - primary education, for example - have grown at rates not very different from that of the population as a whole; they are those clearly related to the size of population. Others - telecommunications may be an example - are tied to the increasing complexity of society. As the number of people and institutions increases, the number of interactions among them increases at an even greater rate. Such components probably fit a growth rate comparable to that of the information sectors as a whole - *i.e.*, about 4% per annum. Finally, a third set of components - the computer industry probably being the most visible example, but higher education, science and technology, and other examples may represent even more fundamental changes. This third set of components have had growth rates spectacularly greater than even those for the information sectors as a whole. They probably represent a fundamental addition to the role of information in society, as well as to the tools for dealing with it. They represent the reasons for the advertisers' gimmick - the 'information age.'

An example that I think falls into the third category is one of special and specific interest to me of course. It is our nations's libraries and especially the large academic and research libraries. A study made some ten years ago, by Oliver Dunn and his associates at Purdue University, fitted exponential growth curves to the academic libraries of the country. They showed doubling rates, depending upon the nature of the institution, varying from ten to twenty years, all significantly greater than Porat's estimates for the information economy as a whole.

Effect upon Productivity

Which brings me to the primary focus of my talk. Given this kind of growth in the information sectors of the economy - what Porat calls 'the information economy' - what effect is it having on our nation's productivity? Is it simply so much 'spinning of the digital wheels' or is information truly a productive component in our society? Obviously, I come to those questions with vested interest in the view that information agencies, and especially libraries, are productive, valuable components of society, and that bias certainly colors my approach to research on this problem. You will have to judge for yourself whether it has effected the results I will present.

But first, let me present what Porat has to say as shown in Fig. 3. To some extent it is as it was to be expected: Information services, and specially those in the secondary components, have been an increasing overhead expense, what Porat sees as a drain on our national productivity. Porat refers

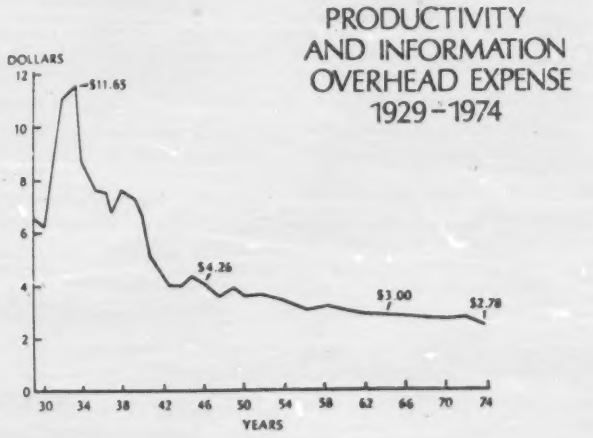

Figure 3

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to the public and private bureaucracies, the growth of paperwork, the costs of internal information systems in providing the means for integration of increasingly larger and larger organizations.

That's a disturbing picture, and I am personally concerned about its impact on national policy concerning information. What are the problems involved in accepting Porat's analysis at face value? The most important one, it seems to me, underlies his distinction between primary and secondary information sectors: on the one hand, that information is a marketable commodity and, on the other hand, that it is an overhead expense. While there are elements of both in each of the two component sectors, generally the primary sector represents the use of information as a capital resource, from which products and services can be derived. I think that this distinction - between information as a capital resource and information as simply part of the machinery of 'doing business' - must be recognized and examined.

The Information Industry

As a starting point for such an examination, it's worthwhile to identify the kinds of companies that are explicitly associated with information producing and selling - the ones that most actively utilize information for the production of marketable products and services - the members of the Information Industry Association, the IIA - as shown in Fig. 4.

Publishing Dun & Bradstreet McGraw-Hill, Inc. Newsweek	Consulting Standard & Poor's Corp. A.D. Little Chase Manhattan Bank
Computer Hardware IBM	Micrographics Disclosure 3M
Indexing Institute for Scientific Information H.W. Wilson Information Bank	Data Base Development Lockheed System Development Corp. Control Data Corp.

Figure 4

The growth of this industry over the past decade has been quite phenomenal, but it represents merely the most 'free enterprise' oriented examples of the organizations providing these kinds of services. In addition to them are the several Federal agencies actively engaged in providing information products and services, the nation's libraries - public, academic, and special or industrial - and those companies providing information services even though they may not be formal members of the IIA.

One measure of the growing importance of information as a capital resource is the increasing number of conflicts arising both within the private sector and between it and the public sector. They concern the ownership of data bases, freedom and equity of access to information *versus* proprietary rights in it the competition between private enterprise and government agencies. In fact, the Federal government has played a remarkable different role in the development of the information economy from that which it has played in virtually any other sector of the economy. For the first time, the federal government has been an active participant, a direct provider of services rather than simply a regulator and subsidizer. The federal government is one of the primary sources of much of the information most crucial in economic decisionmaking, as well as the sponsor of much of the research and development which provides information on which economic progress is based. The result is that the natural tensions between public and private sectors are exacerbated by the extent of direct competition.

It's interesting to contrast this active involvement with the relatively passive role of the government in the areas of agriculture, industry, and personal services. In all of these, the federal government has served as regulator, subsidizer, and one of the consumers, but as participant only minimally. Even in the area of transportation, where the federal government has played a vital role in development by providing major subsidies - rights of way for railroads, construction of national highways, construction of airports, *etc.* - they have not done so as participants in providing the services. On the other hand, in the area of information services, the federal government has played a central role - even to the point, in the case of the postal service, of being a virtual monopoly; if we take the broad range of government, including state and local agencies, the government has played the dominant role in one of the most important of the primary information sector 'industries' - education.

But even if we limit ourselves to those things of primary concern in this talk - the use of information as a capital resource - the federal government continues, as it has for many years and very much so during the past few decades, to be a producer of information as a capital resource as well as the provider of products and services derived from them.

Information as an Economic Resource

A fundamental question that must be answered, however, is whether information can properly be treated as a 'capital' resource. For example, present accounting practice certainly doesn't do so. The point is that information has properties very different from those normally associated with tangible capital resources, like machine tools and buildings. Identifying those differences and determining how they should be treated is itself a major task for research, and I'm not going to pursue it further today. However, a somewhat different approach is to see whether information has effects similar to those of other capital resources, especially as reflected in productivity, the issue with which Porat was concerned.

One means for doing so - and the one that Porat in fact suggests - is to consider 'production functions' and to determine the effects of information utilization within the framework of them. So let's look at one such function, the one that is simplest both mathematically and conceptually.

The Cobb-Douglas Model

It was only some years after I began to apply the Cobb-Douglas production model to information contexts that I realized that the 'Douglas' was Senator Paul H. Douglas who, in addition to being one of the great Senators of our time, was a professor at the University of Chicago, with Paul Samuelson as one of his students. My own interest in the model may well simply reflect the underlying sympathy I have with the political and economic views of Senator Douglas, but that's perhaps irrelevant to this discussion.

Fig. 5 presents this model in its original form and in a number of equivalent alternative forms, each of which exhibits a property of interest. First, the model itself postulates a functional relationship between production - represented by x_0 - and two component means of production,

COBB-DOUGLAS MODEL

$$x_0 = a x_1^b x_2^{1-b}$$

$$x_0/x_1 = a(x_2/x_1)^{1-b}$$

$$\log(x_0/x_1) = \log a + (1-b)\log(x_2/x_1)$$

$$Bx_0 = B(a x_1^b x_2^{1-b}) = a(Bx_1)^b (Bx_2)^{1-b}$$

Figure 5

usually taken as capital - represented by x_2 - and labor - represented by x_1. Expressed in this way, it implies that capital and labor are exchangeable for each other, so that the same amount of production can be obtained from different allocations of resources between the two production components.

The second form is of special interest because it is the one that most explicitly presents the underlying rationale for the model; It says that the production per employee (*i.e.*, x_0/x_1), or productivity, is a function of the capital investment per employee (*i.e.*, x_2/x_1). This picture certainly underlies our modern industrial society, with the view that a steady increase in capital resources will result in increased productivity. Of course, it must be recognized, and the Cobb-Douglas model provides the basis for doing so, that there must be a proper balance between capital and labor; all of one without any of the other would result in zero production, infact.

The third form, the logarithmic form, is of interest because it provides the simplest means for determining the values for the parameters a and b, by the use of simple linear regression. Specifically, one determines the logarithms of values for the two ratios (x_0/x_1 and x_2/x_1) for a number of specific situations; the straight line that 'best fits' (in the sense of minimizing the sum of the squares of differences) then provides an estimate for those parameters, with its slope being the estimate for (1-b) and the intercept the estimate of a.

The forth form exhibits the property of 'homogeneity' - a property that is both valuable and to some extent frustrating. It says that a change in capital and labor that preserves the ratio of relative investment in each will result in a proportional change in product. That property is convenient mathematically, but it is not at all clear that it is exhibited in reality, except over a narrow range of the variables; furthermore, it makes it difficult to deal with certain aspects of production that are not explicitly included in the Cobb-Douglas model as such.

As I mentioned, the Cobb-Douglas model provides means for determining the optimum allocation of resources between capital and labor. One merely maximizes the production (*i.e.*, determines the mathematical maximum for the Cobb-Douglas formula) given a fixed total amount of resources. (Or. phrased in a mathematically equivalent but operationally different form, minimizes the total resources needed to have a specified level of production. This form of stating it is probably more applicable to library contexts, which are the ones I will first be concerned with). The arithmetic involved in determining the conditions for optimization are quite straight-forward, and the result is that the relative allocation of resources between capital and labor should be in the ratio of (1-b)/b, as shown in Fig. 6.

ALLOCATION OF RESOURCES
CENTRAL COLLECTION

Maximize $x_R = a x_1^b x_2^{1-b}$

Subject to $x_1c_1 + x_2c_2 = T_R$

Using Lagrangian multiplier,

$x_1c_1 = bT_R$, $x_2c_2 = (1-b)T_R$

where c_1 is cost per FTE
and c_2 is cost per volume [1000's]

Figure 6

Application to Libraries

My interest in this model arose several years ago, when I was concerned with the extent to which the collection of books in a library could be regarded as a capital resource. This may appear to be a rather trivial example of the main issue I am trying to present, but I think it is quite illustrative. It's obvious, of course, that the book collection of a major library - such as that at UCLA or at the Los Angeles Public Library - represents a major investment and certainly the buildings that house those books would be treated as capital investments in any reasonable industrial accounting system. But does it behave like capital investments?

The exploration of that question has involved the detailed examination of, first, public library systems in a number of states of this country and in Australia, and second, academic libraries. The results have been a substantial confirmation that the collection of books in a library does behave as a capital resource, as far as the Cobb-Douglas model is concerned.

First, with respect to public libraries - at least, to those that do not have a major research function - the production is well measured by data on 'circulation of books.' Those data are relatively reliable, consistent from library to library, and readily available. In the analysis of public libraries, therefore, I used circulation as the measure of x_0, the product.

Turning to the measure of capital, x_2, the basic rationale I was following is that the collection is the fundamental resource of the library, to which all other capital costs should be related. I therefore measured the capital investment by the size of collection. In saying that, however, I am including a number of different kinds of expenditures within the set of capital costs, all of them being measured by the one variable of collection size as shown in Fig. 7. Specifically, an obvious capital cost is the building which houses the collection. Another, not so obvious cost is the labor cost in acquisition, cataloging, and physical preparation of the books themselves. These labor costs are typically identified as 'technical processing' in the library, and I treat them as part of the capital costs, not the labor costs.

Finally, the remaining labor - what is usually called the 'reader services' staff - becomes the labor component x_1. These are the people who actually provide the information service of the library - the circulation of books,

ready reference, photocopying support, *etc.* - as shown in Fig. 8.

CAPITAL COSTS

	Avg. Lby. Costs	FTE
Acquisition	$ 238 K	
Tech. Proc., etc.	253 K	16.8
Storage (@ .50/v./yr.)	233 K	
Maintenance	60 K	6.0
Total	$ 784 K	22.8
Per 1000 vols.	$1680 K	

Figure 7

SERVICE STAFF & COSTS

	Dollars	FTE
Capital Costs	$ 784 K	22.8
Service Staff	$1239 K	82.2
@$15,071 / FTE		
	$2023 K	105
Unaccounted - for Costs	57 K	
Avg. Library Income	$2080 K	

Figure 8

Using these definitions for x_0, x_1, x_2, I have examined the relevant data concerning public libraries in the states of California, Ohio, Missouri, Illinois, New Jersey, Georgia, and for the province of New South Wales, Australia (a rather accidental situation made data available). Fig. 9 summarizes the results in terms of the relevant parameters of the Cobb-Douglas Model: the correlation R (or extent to which the data fits the model), the slope (1-b) and the intercept a. The degree of consistency of these values across a wide range of contexts is certainly encouraging. Beyond that, however, the extent to which the model has predicted actual distributions of resources in quite specific contexts has provided additional evidence that it is descriptive of an underlying relationship.

APPLICATION TO PUBLIC LIBRARIES

GROUP	R	log(a)	(1-b)
California	.70	.71	.65
Illinois	.79	.63	.68
Ohio	.78	.62	.69
Missouri	.64	.67	.63
New Jersey	.56	.53	.64
Maryland	.54	.76	.61
New South Wales	.75	1.02	.62

Figure 9

To discuss this in more detail requires recognition of a fundamental nature of public library organization. The typical public library system involves a mix of a large, centralized collection with a distributed, branch library collection as summarized in Fig. 10. The reason for providing branch

libraries is clear: they make the library more accessible, by bringing it closer to the user. In fact, it is well substantiated that the use of service facilities - such as retail outlets and including libraries - is an inverse function of the distance the user must travel (See Fig. 11).

CENTRAL VS DISTRIBUTED

(1) Centralized concentrated collection. The user goes to it for Research & Reference - guaranteed, rapid, chained access. A crucial function.

(2) Distributed collection. The user finds it more accessible for use of high demand material & for circulation of it.

Figure 10

INVERSE SQUARE LAW OF UTILIZATION OF INFORMATION RESOURCES

$$x_{ij} = k / D^2$$

1) Gravity model for service industry
2) Data from library use studies
3) Regression on circulation as function of various parameters
4) Other data

Figure 11

This means that, all else being equal, the use of a public library system is a function not only of the staffing and size of collection but of the branch library distribution. As a result, the Cobb-Douglas model must be modified to reflect the number of branches (assuming that the actual distribution appropirately matches the population distribution). The resulting criteria for optimum allocation of resource is thus considerably different from that for a single point, concentrated collection, as illustrated in Fig. 12.

ALLOCATION OF RESOURCES
BRANCH COLLECTION

Maximize $x_B = \frac{B}{B_0} a x_1^b x_2^{1-b}$

where $x_1 = Bm$

Subject to $x_1c_1 + x_2c_2 = T_B$

Result:

$$x_1c_1 = \frac{1+b}{2} T_B,\ x_2c_2 = \frac{1-b}{2} T_B$$

$$x_1c_1 = bT_R,\ x_2c_2 = (1-b)T_R$$

Figure 12

Since a public library system is a mix of central libraries and branches, the design equations for the total operation must be a mix of the corresponding criteria for optimum allocation, based on the division of budget between the two components of service, as shown in Fig. 13.

The result of applying the design criteria to a particular branch library system, in comparison with the actual allocation made by that library is presented in Fig. 14. shows that the actual allocation is within about 3% of the optimum.

DESIGN EQUATIONS: TOTAL OPERATION

$$T_B + T_R = T$$

$$\frac{1-b}{2} T_B + (1-b) T_R = CC_2$$

$$\frac{1+b}{2} T_B + b^w T_R = (S - .05C) C_1$$

WHERE: C IS COLLECTION SIZE
S IS TOTAL STAFF

$$X_0 = \frac{B}{B_0} \frac{a T_B}{2} (1+b)^b (1-b)^{1-b} + a \frac{T_R}{2} b^b (1-b)^{1-b}$$

Figure 13

APPLICATION TO L.A.P.L. BRANCHES

	Theoretical Optimum	Estimated Actual
Reader Services	$8,748K	$8,919K
Collection	3,660K	3,489K
Total	$12,408K	$12,408K

Figure 14

66

When I moved from public libraries to academic, research libraries, however, I did so with some trepidation. The measurement of product in the academic research library is much more complicated than it is in the public library. Whereas circulation appears to be completely adequate for measurement of the typical public library's services, the academic reseach library serves a much wider range and variety of needs. It supports the undergraduate instruction program, the graduate student education and research needs, the faculty research needs, and in many cases a high level of 'organized research' activity. Each of these is quite different in the nature of their use of th library. Furthermore, for those other than the simplest of undergraduate ..eeds, there are no generally accepted methods for measuring the extent of utilization. There are no counts maintained by any academic research library of 'numbers of research users.' In fact, it's difficult to identify means for measuring such uses (See Fig. 15).

MEASUREMENT OF PRODUCT

(1) Circulation : Measurable, consistent (reasonably so), reliable. Many other uses are probably proportional.
(2) Research : Fundamentally different and probably unrelated to circulation. Very difficult to measure

Figure 15

In trying to deal with the academic research library, therefore, I was forced to use surrogate measures - variables that would be related to research use at least to the extent of providing some insight into the relationships. Three surrogate variables came to mind and were independently used: inter-library lending, Ph.D. production, and number of faculty. The rationale for the first is that by policy, inter-library loans among academic institutions are to be for research purposes; aside from that, they provide a clear measure of the perceived quality of the libraries as research support.

67

As with the public libraries, the measure of capital is taken as the size of the collection (but including in the associated costs those for the buildings to house the collections and technical services staff involved in acquisition and cataloging of it). The labor component is then, again, as with the public library, measured by the remaining reader services staff.

The results are shown in Fig. 16. Again the three parameters are the correlation, the slope, and the intercept. The consistency among them as well as the similarity of them to those from the public library context adds greatly to a feeling of confidence that an underlying phenomenon is being measured - viz, the role of an information resource as a factor in productivity.

48 ARL LIBRARIES

X_0 = ILL, PhD, FAC

X_1 = SRVST

X_2 = COLL

X_0	R	log(a)	(1-b)
ILL	.352	1.323	.605
PhD	.564	-0.422	.649
FAC	.432	0.404	.554

Figure 16

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Application to Institutions

The next step was an easy, though quite radical shift in emphasis from the library as the productive organization to the university - the institution within which the library represents the 'information resource.'

In his position as Vice-President of the American Council on Education, on *An Assessment of Quality in Graduate Education,* Allan M. Carter looked at the university library as one measure. He said, 'The library is the heart of the university; no other single nonhuman factor is so closely related to the quality of graduate education.' He identified an overall rating of quality of faculty at a number of institutions and compared it with an index of library resources (which includes, as it's dominant variable , the size of the library). He finds a correlation of R=.794 between the two. As I will show, this is so consistent with the results obtained from application of the Cobb-Douglas model that it gives some degree of confidence that we are dealing with an underlying relationship, rather than simply a numerological coincidence.

The product of the university, at least as far as research and research education is concerned, can probably be measured by the number of PhD's produced; the faculty are the producing labor, and if we use the collection of the library as the surrogate measure for the capital resources of the institution, we get the picture shown in Fig. 17. Again, there is remarkable consistency between these values for R, (1-b), and log(a) and those for libraries as such.

48 UNIVERSITIES

X_0 = PhD

X_1 = FAC

X_2 = COLL

X_0	R	log(a)	(1-b)
PhD	.655	-.787	.658

Figure 17

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I have applied comparable analyses to the libraries of goverment agencies and industrial corporations. Although the data are much more limited and more uncertain, the qualitative picture is quite consistent.

Information Resources and National Productivity

The result of these studies of the Cobb-Douglas model as it applies to libraries was a growing degree of confidence that it indeed reflects an underlying value of information resources as capital resources. So it was with some degree of good expectations that I finally applied the model to Porat's data.

Porat provides a complete input/output analysis of the national economy in 1967, in the framework of a division of it into 107 industries. Using his definitions of the primary information sector, he allocates industries or parts of industries into two main groups: one, the (primary) information industries and, two, the non-information industries. He provides data for each industry showing the purchases from all other industries and then accumulates them into three groups of expenditures:

1) Input (*i.e.*, purchases) from the (primary) information industries
2) Input from the non-information industries
3) Input from within the individual company (*i.e.*, added value input).

The sum of these three is then the total input for the industry, which by definition is synonymous with the total output or sales.

Porat then determines the precentage of value added input that each industry spends on internal information - the secondary information sector. This percentage varies from industry to industry, just as the purchases from the primary information sector do. Taken together, those two - the purchases from the (primary) information industries plus the part of added value costs going to internal (secondary) information expenses - provide a measure of the total investment each industry makes on information.

The measurement of product from industries is not a simple, straightforward issue. Although the ideal might be to measure it in concrete terms - so many automobiles manufactured, so many books published, so many ton mined, - those data are not readily available, are likely to represent a rather mixed bag for a given industry, and are not directly comparable from one industry to another. As a result, the natural alternative is to use some dollar measure of gross sales. Those data are generally available and do provide both a consistent and a comparable basis for measurement. Even this answer has its flaws, however, since costs may be incurred that, while they may be passed on to the consumer of the product, may not be essential to the production of it. This issue becomes especially important when we are trying to evaluate the significance of a particular component of cost, such as in our case information investment.

To deal with this sort of issue most directly, I identified the net production as the gross output less the costs of information investment (and Porat does much the same thing when he talks about 'information overhead' as the ratio of net product to information input). In this way, an irrational investment in information would not artificially inflate the total production.

The third component variable in the Cobb-Douglas formula is labor. The data for employment in each industry are readily available. In fact, I took them from *Statistical Abstracts*, since it was most readily at hand.

Thus we have the three variables for the Cobb-Douglas model:

x_0 = Net Product (GNP less information investment) for each industry
x_1 = Total Employment for each industry
x_2 = Total Information investment (counting both primary and secondary investment expenditures)

Fig. 18 shows the values for the relevant parameters, the correlation (R), the slope (1-b), and the intercept log(a) derived from a regression analysis on the non-information industries. It is really quite remarkable that a single variable - the information investment per employee - should account for over 50% of the variance across these industries. It is even more remarkable that it does so with values for (1-b) and log(a) so similar to those for libraries.

In fact, it is remarkable enough that I was concerned - and even now still am - that the results might be a reflection of just manipulation of numbers rather than of reality. To test that possibility, I took another set of data - capital expenditures (for durable goods of all kinds) for each industry

NATIONAL INDUSTRY

X_0 = TOTAL - INFORMATION INPUT
X_1 = EMP
X_2 = INFORMATION INPUT

	R	log(a)	(1-b)
Noninformation Industries	.729	1.316	.558

Figure 18

and adopted a completely parallel approach to analysis:

x_0 = Net product (GNP less capital investment) for each industry
x_1 = Total employment for each industry
x_2 = Total capital investment for each industry

This in fact is the classical context for application of the Cobb-Douglas model. The result of a regression analysis are shown in Fig. 19. The correlation is positive, but quite low, as in the slope. I interpret this as

NATIONAL INDUSTRY

X_0 = TOTAL
X_1 = EMP
X_2 = CAP

R	log(a)	(1-b)
0.217	1.54	0.121

Figure 19

saying that industry in the United States is now so well developed in its capital resources (in the traditional sense) that the marginal value of additional expenditures is really quite low. In contrast, the marginal value of investment in information resources, in the broad sense of Porat's definition, is quite large.

The purchases from the primary information sector are of two kinds - purchases of durable goods (such as computers) and purchases of services. I conjuctured that the durable goods purchases would behave like the capital expenditures; in fact, they are included within capital expenditures. Analysis showed that they do, with a low slope (or rate of contribution to productivity) although with a relatively high correlation.

The Significance of Correlation

This can be summed up in a single qualitative statement:

> Those industries with high productivity tend to be those industries with a high level of information expenditures per employee.

Of course, the fact of a high correlation between two variables does not imply causality or even necessarily a relationship. In the case of productivity and information investment, therefore, the most that we can say, based solely on the data I've presented, is that the two variables are closely related. It may be that information investment indeed does to some extent 'cause' an increase in productivity; certainly, the 'high technology' fields depend heavily upon information; better management depends upon good communications and good internal management information systems; better educated and informed workers may well be more productive; better information may well result in increased sales and better relationships between product design and market needs. On the other hand, it may also be that the more productive a company, the more 'excess' resources it has to spend on information services; greater profitability may simple provide the resources for exploration, research, and development - all of them information consuming - without necessarily resulting in increased productivity.

Despite that caveat, I think the evidence for a close relationship between productivity and information investment is convincing, and whether that relationship is causal or not is rather immaterial. Increased productivity and increased information investment go hand-in-hand, and management, as well as government policy, should look to criteria for determining the optimum allocation of resources so that the investment decisions are made as

rationally as possible. It is this that makes 'production models' so crucial, since they provide the tools for applying such criteria. The Cobb-Douglas is simply one of them - the most obvious, direct, and simplest to justify, perhaps. The fact that it applies so well and so consistently makes it worthwhile pursuing this issue in much more detail.

But if this statement is true, as the evidence I've presented seems to imply, how do we reconcile it with the results that Porat presented, in the context of what he called 'information overhead'?

> The net product, per dollar expended on information, has been steadily declining over the last fifty years.

Especially significant is the fact that at the same time the percentage of the labor force involved in the information sector has been steadily, even dramatically increasing.

It turns out that Porat's results are a direct and natural consequence of the Cobb-Douglas formula as illustrated in Fig. 20. If we divide through by x_2, rather than by x_1 as I have heretofore done, we get the equation

$$x_o/x_2 = a(x_1/x_2)^b = a(x_2/x_1)^{-b}.$$

This clearly states that, as the investment per employee increases the production per dollar of investment must decrease. But more than that, we have from Porat's data the basis for an independent estimate of the parameter (b). Using the two years of 1974 and 1957, the data in his Figures 7.2 and 9.2 show:

Year	Figure 9.2 x_o/x_2	Figure 7.2 x_1/x_2
1957	$3.25/$1.00	.65/.35
1974	$2.78/$1.00	.52/.48

Putting these values into the equation I've given above, we can solve for (b) and we get the value

$$b = .285$$

A regression on the same equation, using the data for 1967 that has been used in the other analyses, yields a value b = .290. (The solution for log a is much more difficult to compare because the variables involved are being measured in different units - numbers of employees versus dollars of information expenditures, but the slopes are not as sensitive to those differences.)

INFORMATION OVERHEAD
AND COBB-DOUGLAS

$$x_0 = a x_1^b x_2^{1-b}$$

$$x_0/x_2 = a(x_1/x_2)^b = a(x_2/x_1)^{-b}$$

Regression on 1967 data yields b = .290

Porat data on information overhead and distribution of labor in 1957 and 1974 yields b = .285

Figure 20

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Summary

Let me now bring this to a close by briefly summarizing what I have tried to present to you.

First, I've identified a context - the information age in which we now find ourselves - within which there are so many problems begging for the attention of university research efforts. And they are problems far greater and more significant than the technical problems in application of computers that to date have been the primary focus of those concerned with the revolution in which we are now engaged. They are problems that need the attention of the humanists, the social scientists, the economists, not the technologists.

Second, I've presented some data that puts the magnitude of this revolution in perspective. Whatever the definition of the information economy may be, any component of our economy that has been growing at an exponential rate of 4% per annum for over 100 years needs to be looked at very carefully.

Third, I've presented some arguments, some data, and some analyses aimed

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at demonstrating that information resources - such as the books in libraries - are capital resources, active factors in the production of goods and services, rather than merely 'overhead'.

Finally, I have presented analyses that I think support the view that productivity in our economy is closely linked with the level of investment in information services per employee - the greater that investment is in an industry, the greater the productivity of that industry.

Dr. James G. Miller, President of the University of Louisville, at one time Director of the Mental Health Research Institute at the University of Michigan, and most recently elected a Co-Chairman of the Board of Directors of the Fund for the Republic, has for many years been concerned with the analogies among different levels of 'living systems' - from the simplest of single-cell organisms to the most complex of multi-national political and economic systems. He identified many hypotheses as universally applicable across the full range of systems. Among them it this:

> 'Up to a maximum higher yet attained in any living system, but less than 100%, the larger the percentage of all matter-energy input that it consumes in information processing controlling its various system processing, the more likely the system is to survive.'

I think that the results I've shown for the efficiency with which the 'matter-energy' processes in our economy (*i.e.*, the net product of industry not including the information industries) are performed - *i.e.*, that the efficiency increases as the information investment increases - are completely consistent with that hypothesis.

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A 'LINC' BETWEEN UNIVERSITY LIBRARY, INFORMATION AND COMPUTING SERVICES USING VOICE INPUT/OUTPUT

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As it becomes technologically and economically possible for computers to be used to help with a wider and wider range of university activities, it becomes harder for the unsophisticated user to distinguish between on-line services giving access to different facilities such as the university library circulation record, remote information services, the research computer, the administrative computer, the word-processing service, *etc.*

This note argues that it should be possible to provide an integrated service giving a common approach to all on-line services. It is also suggested that voice input/output using the ordinary telephone may well suffice "for all of the people some of the time and for some of the people all of the time".

The University as an endo-exo-*Skeletal Organism Supported by Information Flows*

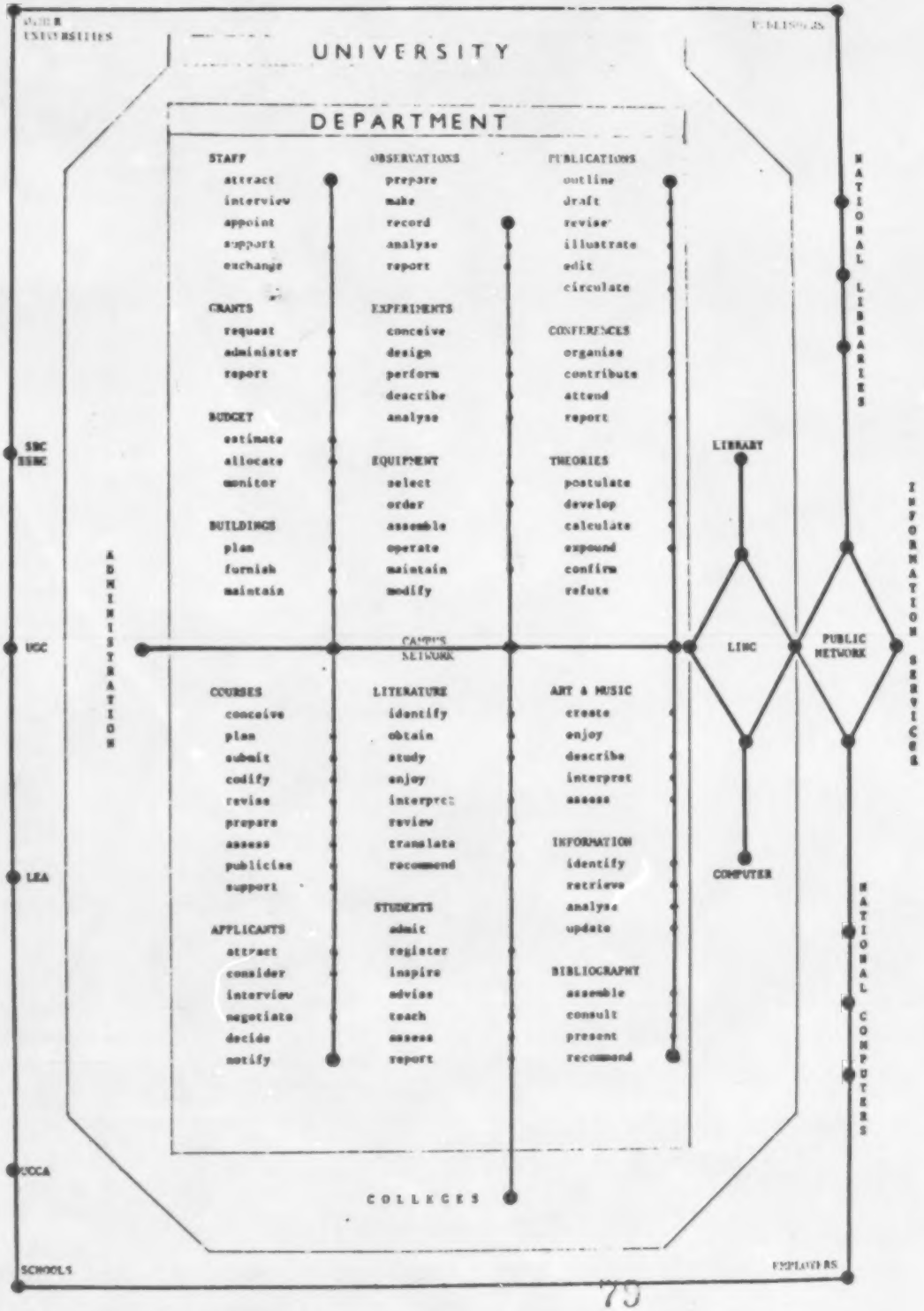
The accompanying diagram lists most of the essential activities of a typical university department required to further its twin aims of education and research, with a "skeleton" both internally and externally to indicate the need for information to flow between the different elements to support the activities. Today many of the information flows would be carried by mail, but an increasing proportion will be transmitted electronically: the black circles on the network indicate these activities which might in future be aided by an integrated on-line Library, Information and Computing (LINC) service, often acting as a back-up for the departmental word-processing function which is relevant to a great many of the activities.

As an example, a social scientist studying some aspect of group behaviour could first identify previous work in the field by interrogating remote bibliographic databases to supplement his own and his colleagues' memories, then he could draft and redraft his application for research funds on his department's word-processor, perhaps submitting an early draft to the Social Science Research Council (SSRC) by electronic mail for preliminary comment. First notification of the grant of funds might come by the same means, as could referees' letters when considering applicants for the post of research assistant. He could retrieve the results of previous surveys elsewhere from the computer-held national archive, and store particularly relevant parts on the local university computer to avoid continually incurring high communication charges; the opposite process would submit his results to the archive for others to use in the future. The departmental word-processor could help again with compiling draft questionnaires and reports, with high-quality printing devices elsewhere producing the final output. The university computer or a national centre would have the sophisticated statistical programs required to analyse his data, and could produce easily-understood graphical representations of the results. His preliminary findings might be circulated to "the invisible college" of scholars in the same field in other universities by means of the network, which could also carry their responses in time to be incorporated in his paper. In theory, the researcher could do all this without leaving his office, using only the telephone and its attachments as described below, and hardly being aware of the fact that the different processes he had initiated were carried out in many different places on computers operated by different organisations.

Voice input/output as a First Introduction to the LINC Service

Many scientists and engineers are now quite familiar with the use of computer terminals, but this is not true for staff and students in other faculties, who often feel there is an insurmountable threshold between them and the computer. They are all, however, quite happy to use the telephone: I am therefore proposing that access to the LINC service should be primarily through the ordinary telephone instrument, already to be found in all staff offices and many teaching rooms.

The points just made are even more important in the world outside the university, so there are strong commercial reasons for the current rapid development of voice input and output for computers. The voice input



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John HAWGOOD

technology is lagging behind that for output, because of the problems of different pronunciations, accents and voice characteristics, but enough has been done to inspire confidence that limited-vocabulary voice input will be widely and economically available within a year or two. The output side is already routine and quite acceptable using a limited repertoire of pre-recorded sentences, but the direct speech synthesis approach with its wider potential will probably supplant the pre-recording method quite soon.

The first services to be offered by the LINC service should therefore be those requiring only very small input vocabularies, perhaps little more than "Yes, no, one, two, . . . , nine, zero", which would permit the coding of standard messages like "Has my program been run yet? ", "What time does the library close today? ", "What's the uncommitted balance of my departmental budget? ", "Please circulate my document number . . .", "When may I come and see the Vice-Chancellor? ". Such messages would all be spoken as short sequences of code numbers, and the computer would respond first by speaking the message out in full to make sure it had heard aright, then going on to formulate and speak the reply (either pre-recorded or synthesized). Simple calculations would also be possible.

There would soon be a demand for an extension of this to allow alphabetical input: this could be provided by increasing the input vocabulary to include letters and simple words or by attaching a typewriter-like keyboard with a small character display to the telephone. The latter would be very much more flexible, but the former would still use only the unmodified telephone already available everywhere; thus preferably both approaches should be followed together. Once alphabetical input was available, a number of other services could be provided, including the editing of pre-prepared texts or programs held in the computer memory, keyword searching of bibliographic files, short interactive data-processing jobs, *etc.* The ordinary telephone system is not, of course, suitable for high-volume transmission or long sessions; those requiring these facilities would have to install or go to a terminal connected to a dedicated network.

Obviously the concept outlined above requires an intermediary computer system connected to the telephone system on the one hand and to the various services to be accessed on the other, handling a number of conversations simultaneously. It must convert voice input messages from the user into the different languages recognised by the defferent services, and *vice-versa* for output. There are two distinct elements to the process just glibly summarized - firstly speech recognition and synthesis and secondly the provision of a common command and interrogation language to obtain at least the elementary facilities of a number of disparate services. Input from the LINC keyboards would bypass the speech recognition module and feed straight into the second module, which we might call FINDER, standing for "File Interrogation, Draft Editing and Retrieval".

CONCLUSION

I believe there is a case for the establishment of an 'academic service unit' to incluse the University Library and the Computing Service, mainly to cater for the continually increasing area of overlap between their functions. A major benefit of a merger to both units would be the possibility of providing specialized subject expertise in more fields by drawing on a larger pool of librarians and programming advisers. This recommendation remains valid whether or not voice input/output is adopted for short interactions with the LINC service.

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INFORMATION MEASUREMENT SYSTEMS

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The modern development of science and technology has led to the production of complex dynamic systems, technology processes which have a great number of different physical characteristics. Electrical measurements are one unifying method of receiving objective quantitative information about these characteristics. This is possible by the application of special technical resources which constitute an important element in industry, scientific systems, etc. In all cases perfection of these measurement resources allows us to imporve the quality and efficiency of the system.

It is widely known that electrical measurements is a physical experiment applying special technical resources which enables us to receive quantitive information about different physical values.

Historically, these technical resources have come a long way from simple measurement transducers and instruments to complex information measurement systems (IMS). The development of the IMS would be impossible without advances in electronic technology, control systems, and computers.

As a rule the IMS is used for the solving of special problems, some of which are collecting, transducing, transmitting, evaluating, storing and retrieving information for the user or other systems on another level.

From modern developments in the IMS, the information evaluation complex (IEC) has evolved. The IEC represents a union of hardware and software and solves the same problems as an IMS. However it differs from the IMS by permitting more functional possibilities and freer programmability, using mini- and microcomputers as a foundation, normalization metrological characteristics as measurement blocks, that is computers blocks. In practice, the IEC represents the union of the modern IMS with computers.

The efficiency of the IEC depends on the organization of its structures and the evaluation of its information processes.

Before considering some problems concerning the construction of the IEC it is useful to present the following classification.

The main classification elements are:

- purpose;
- character of the input information;
- character of the output information;
- hardware characteristics;
- software characteristics.

Let us examine these aspects in more detail.

I. 1. By purpose we have:
- IEC measurements;
- IEC automatic control;
- IEC recognition features;
- IEC technical diagnostics.

2. From the application:
- universal;
- problem-oriented
- unique (single object)

3. Orientation in space:
   - near
   - distant

4. Structures:
   - nonadaptive;
   - adaptive.

II. 1. Character of the input information:
   - analog;
   - digital.

2. Quality of information:
   - homogeneous;
   - non-homogeneous.

III. 1. Character of the output information:
   - registration information at display;
   - recording the information;
   - transmitting the information to the level.

2. Information use:
   - feedback;
   - non feed-back.

These factors determine the main units and principles of hardware and software construction.

IV. The main hardware units are:
   - measurement system;
   - interface;
   - computer (central unit).

1. The measurement system can have:
   - common measurement channels;
   - parallel measurement channels;
   - scanning measurement channels.

2. Next we have the hardware interface:
   a) - series
      - radial
      - unibus

   b) method of synchronization
      - synchronous
      - asynchronous

   c) interaction with the central unit:
      - active
      - passive

3. The core of the IEC is the computer or computers.
   a) - special
      - universal

   b) quantity of computers
      - single-computer IEC
      - multicomputer IEC

   c) evaluation of the information
      - central
      - local
      - mixed

V. One of the most important parts of different IEC's is the software (according to specialists, 70-80% of the price):
   - special
   - applied

   a) special:
      - control program
      - evaluation program

It is clear that this classification is not complete, but aims to illustrate the important elements of the IEC

which we must take into consideration during its design and construction for different purposes, types of input and output information.

One simple method which saves time and money during the design of the IEC is that based on constructing with aggregative instruments of measurement and computer technology, which have metrology, information, construction and exploitation compatibility and functional completeness.

It is impossible to implement the IEC without a formal technical description. The technical description has to reflect the peculiarities of the measurement object, the character of measurement processes, the appearance of output signals of transducers, the evaluation algorithm for measurement information, hardware and software requirements, and exploitation conditions.

It must be emphasized that the process of planning the IEC is a very complex problem. Initially we have to find the different substructures for the IEC which can solve one or several problems and minimize the final structures needed for solving an entire problem. After that as a rule we have to determine the errors of measurements, evaluation of information and try to choose a single structure which has the minimum error value and satisfies other quality criteria.

It is clear that to find a satisfactory solution to the problem of constructing and utilizing an IEC, it is necessary to answer certain questions, some important ones of which concern:

- construction and development of aggregate resources of measurement and computer technology;
- development of methods of IEC metrology testing;
- construction and development of the interfaces;
- development of methods for increasing accuracy and speed;
- preparation of special and applied software;
- preparation and training of adequate engineers.

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ISSUES IN DISTRIBUTED DATA BASE DESIGN

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Logical bases of DDB are discussed. Major issues in DDB design are explained. Choosing a meta data model, allocation of multiple copies of a file, maintenance of directories, file splitting, query processing and concurrency are among the issues covered.

KEYWORDS: DATA BASES, DISTRIBUTED DATA BASES, GEOGRAPHIC LOCALITY OF REFERENCE, COMPUTER NETWORKS, MULTIPLE COPIES OF DATA, FILE SPLITTING, DIRECTORY, CONCURRENCY, QUERY PROCESSING.

I. Introduction

Early data processing began with unit record equipments. These electromechanical devices led to important improvements in efficiency and effectiveness of data processing; this coincided with the needs of emerging large and complex organizations. Later, in the 50's, computers were used in data processing, leading great improvements in speed and capacity of information systems. Each functional area in the organization developed its own DP applications. However, this new approach was unable to meet the information requirements of large organizations which had already diversified horizontally and integrated vertically. First of all, each application was developed as a separate unit so the applications were not integrated. This limited the capacity of information systems, because some information which existed in pieces in the information systems of some functions were not accessible due to the lack of integration and coordination among these applications. Secondly, the same data were stored at several places, in other words data redundancy was high. The result was waste of space and possible inconsistencies among these multiple copies of data. Thirdly, application software were implemented according to the characteristics of available hardware. As new information needs arose and new hardware became available all the previous software had to be modified. That is, a low level of data independance was achieved [1].

By the late 60's, extensive advances had been made in the fields of purchasing, sales, finance, production, personnel and marketing. New techniques were needed to coordinate and integrate all these functions in order to enhance the overall performance of the organization. This can be achieved by a sound Management Information System (MIS). As a result of this need for an MIS and the drawbacks of EDP applications, the concept of Data Base Management Systems (DBMS) emerged in late 60's [1].

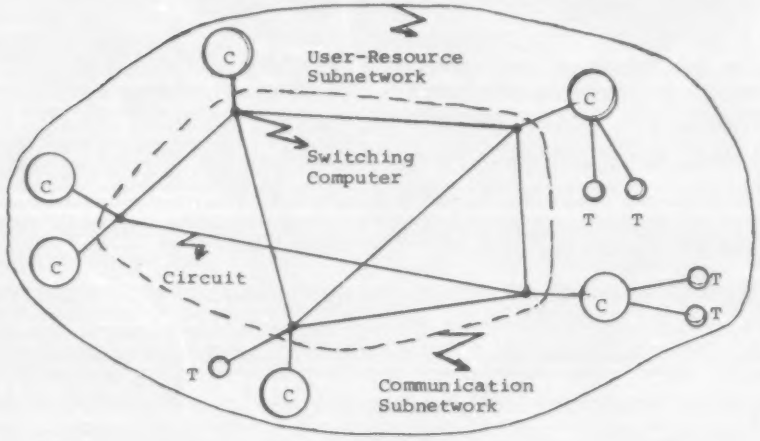
A Data Base is a common pool of information for the whole organization, shared by all the users. It overcomes the deficiencies of DP explained above and facilitates centralized control for the whole organization. However, it also creates new technical issues and extensive research is being carried on them. As it is seen, while the early DP applications show a decentralization tendency, DBMS shows a centralization tendency. Even though a centralized DB facilitates organization wide control, it also creates some problems which will be explained below. Distributing the Data Base also becomes a possible alternative.

A Distributed Data Base (DDB) is a set of files stored in different nodes of an information network which are logically related either by functional relations or because of being multiple copies of the same file in such a way as to constitute a unique collection of data [2]. This definition emphasizes two points: First, data is distributed at different nodes of a computer network according to the creation and/or use of data. Secondly, this data distribution is done in such a way that these distributed pieces can be seen as a unified whole,

independent of data distribution. Hence, a DDB is a decentralized system which facilitates centralized control at the same time.

DDB may only exist on computer networks. Therefore, it may be meaningful to say a few words on computer networks. A computer network consists of two components (Figure 1).

1. User-Resource Subnetwork: Collection of hosts (computers) providing service to end users or other hosts.
2. Communication Subnetwork: Collection of switching computers and circuits among them, providing communication among host computers [3].



C: Host Computers
T: Terminals

Figure 1. A Computer Network

II. Why Distributed Data Bases?

Some of the reasons forming the rationale for constructing DDB are as follows:

1. Geographic locality of reference: Some of the data are created and/or used frequently in a particular geographic locality. Hence, it is reasonable to keep these data locally. At the same time, other nodes may also require access to these data. However, such remote accesses are rather infrequent. In case of frequent remote access another copy of the same data may also be kept.
2. Functional locality of reference: Similar to geographic locality of reference, some data is created and used by a particular functional unit of the organization.
3. Availability of commercial communication networks and facilities and advances in technology of computers and communication.
4. Problems created by centralized DB:
   a. The centralized DB may become too large. Even though maintenance of such a large DB may be feasible with current technology, it may be too costly.
   b. There will be a heavy communication traffic around the central computer where the DB is kept and this may decrease the efficiency of DBMS and response time.
   c. If a component of centralized DBMS fails, the whole system may become inaccessible. However, in a DDB if one component fails, the rest of the system is still available for use.

III. Issues in DDB Design

In DDB, issues of centralized DBMS are created as well as further complicated by geographic distribution of DB. In the following paragraphs these issues will be discussed briefly [4].

1. Network Data Model

In DBMS a meta data model is needed and various user

views are derived from it. These user views are mapped to a common schema. A data model is also needed in DDB to facilitate network wide data sharing. In a heterogeneous DDB, such a common data model will be used in coordinating various DB constructed according to different data models. Implementing a homogeneous DDB is much easier because the same data model is used throughout the network.

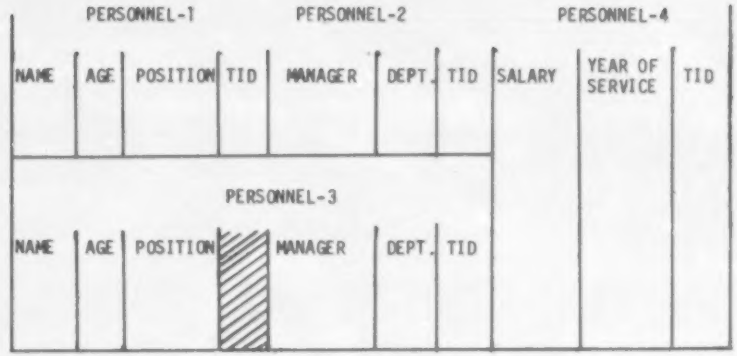
2. Multiple copies of a file

Copies of a file may be stored at several different nodes. This data redundancy improves data availability and accessibility, reduces response time, and facilitates load sharing among the host computers. However, it also has several disadvantages. Firstly, there is the cost of additional space needed to store the redundant data. Secondly, updating of redundant copies and maintaining the integrity of DDB become more complex. If the update volume is high, keeping multiple copies may become too costly.

'Where to allocate how many copies of a file' is the first problem area investigated in DDB. Integer programming models minimizing total operating cost or average access time under the constraints of given storage capacity and availability level of files have been developed [5].

3. File Splitting

Large files may be split into small subsets and these subsets may be stored redundantly. Hence, data availability and accessibility is increased. The following is a file splitting technique designed for relational model and implemented in SDD-1 [6]. A fragment is a rectangular subset of a relation. In figure 2 the PERSONNEL relation is divided into 4 fragments.



PERSONNEL - 1: PERSONNEL WHERE SALARY > 30000
Projected on NAME, AGE, POSITION, TID

PERSONNEL - 2: PERSONNEL WHERE SALARY > 30000
Projected on MANAGER, DEPARTMENT, TID

PERSONNEL - 3: PERSONNEL WHERE SALARY <=30000
Projected on NAME, AGE, POSITION, MANAGER, DEPARTMENT, TID

PERSONNEL - 4: PERSONNEL
Projected on SALARY, YEAR OF SERVICE, TID

Figure 2. Splitting a Relation

If fragements of a relation are redundantly stored at different nodes, there will be more than one way to reconstruct it. Each such collection of fragments which forms a complete and non-redundant copy of the relation is considered as a materialization. The Tuple ID (TID) is repeated in all the fragments to avoid ambiguity in forming materialization.

4. How to address the resources in a DDB

Queries directed for a local data base are processed by using the local directory. A Global System Directory is also needed to process queries involving data from several nodes. These directories may contain some or all of the following information [6]:

- Parsing information (file names, domain names, ...),
- Performance information (cardinality of relations, selectivity ratios for restrictions, joins, ...),
- Integrity information,
- Access and update strategies,
- Information to locate data of interest.

Local directories are kept at the respective nodes. There are four alternative strategies for maintaining Global System Directory:

- Keeping it at a central site,
- Storing a complete copy at each site,
- Splitting it for all or some of the sites non-redundantly,
- Splitting it for all or some of the sites redundantly.

Each of these alternatives has its own advantages and disadvantages. However, the determining factor is the volume of updating for the directory itself.

5. Query processing

There are two components of query processing in DDB: Local processing and transmission of intermediate results from site to site. Hence, improvements in any one component will also improve efficiency of query processing. In all query processing methodologies, possible local processings are performed first. Then, there are two possible ways to complete the processing:

a. Move all the intermediate results to a single site and do all the final processing there. This is a crude solution and requires transmission of large volumes of data.

b. Decompose the query into subqueries and then execute these subqueries in serial and/or parallel fashion, hence moving data only when needed. Most of the optimizing algorithms start with an initial feasible solution as in (a) and try to improve it with possible movement of intermediate results among sites [7,8,9].

Total query time or total query processing cost may be minimized. These depend upon the speed of communication lines, location of data, type and sequence of operations.

6. Concurrency

Integrity is the correctness and completeness of the data stored in the DB. Data redundancy and concurrent updates may cause the storage of inconsistent data in the DB. In concurrent updating, transactions may nullify each other's effects. Thus, safeguards have to be taken to avoid such situations. In a network it is difficult to synchronize the local clocks, further complicating the concurrent update operations. At the same time, it may not be expected that all of the copies of a file will be identical during an update operation. However, after a sufficient amount of time elapses, all the copies should have the same data values. Several updating strategies have been proposed:

- Locking is the widely known and easiest strategy. However, it limits concurrent sharing of the DB.
- Primary site: One of the sites is designated as a primary site and all updating is first directed to this site. Then, this site, after updating its own copy, transmits update transactions to the other sites having copies of the file [10].

- Conlifct graph analysis: Transactions are classified statically and possible conflicts among them are determined and represented as a graph. During run time transactions from conflicting classes are synchronized [11].
- Majority consensus algorithm: A voting scheme is used to determine whether an update request can safely be performed [12].

A good updating algorithm should be robust to host or communication line failures. That is, in case of such failures updating operation should continue and failed sites should be able to recover after they are repaired.

IV. Conclusion

Several DDB have been implemented so far: SDD-1 [6], Distributed Version of INGRES [10], POREL [13] and POLYPHEME [14] are some of these. DDB seem to be a logical extension of DBMS. It may also be expected that they will be a utility for Management Information Systems in the years ahead.

V. ACKNOWLEDGEMENT

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INTERNATIONAL STANDARDISATION OF MODULAR UNIVERSITY PROGRAMMES

G u s t a v T h u r o

1. Two essential problems in higher education

1.1 There are not enough good textbooks in the world

Students and others who want to learn the newest state of knowledge of a particular subject are often confronted with a difficult task. They have to study a great number of textbooks and other information sources of different quality, the contents of which are often not presented in a sufficiently comprehensible way. This makes evaluation and processing of the material unnecessarily difficult.

Text-books are not related to a common ordered system of subject matter. The required co-ordination of the work of individual authors because of the necessity for a mutual delimitation of subject matter within a wider frame of reference normally occurs on only a very loose basis. The result is a confusing agglommeration of many text-books belonging to a particular field, the contents of which overlap considerably, yet in a completely irregular manner. On the other hand, there are many fields which are insufficiently dealt with in text-books. Because of the rapid development of knowledge, text-books very quickly become out of date. It is time-consuming, and involves a great deal of effort to familiarize oneself with a particular area of study with such a supply of text-books.

There is no dispute about the fact that good text-books are urgently needed, and are of enormous importance for the improvment of the entire system of education. In this connection, Professor Maier-Leibnitz, president of the German Research Association, has stated: "Good teaching is the most important basis for the future development of knowledge, and all its applications. Good text-books also require highly qualified academic experts. It is as important as it is difficult to describe wide fields of knowledge again and again, to make them more and more simple and transparent and available to the many. There are not enough good text-books in the world .... but very few people involve themselves with this, because they are working on small contributions, in order to publish as quickly as possible ..... At the same time, there is a market for the best text-books, because they can be translated into every language, and the situation is not such that, in many subjects at least, the best already exists, somewhere in the world ..... Where we can, we try to awake the interest of researchers in the description of their results for a wider range of public; but that is not enough. Great and constant efforts on the part of many are necessary." (L 1)

Prof. Dr. Ing. Fritz Leonhardt, an internationally recognized scientist and the author of numerous text-books which have been translated into many languages writes (L 2): "It is without doubt correct and important for the future, that in many subjects instruction should be better founded and that students be supplied with suitable learning aids.... In my recent lecture at the International Congress for the

Education of Engineers in Darmstadt, I recommended that such monographs or state-of-technological-development reports should be further developed. The task of writing such teaching aids should be given to the greatest experts, and in this way it should be organizationally ensured that unnecessary duplication of work, with the resulting danger of poor quality, be avoided.

In addition, Leonhardt demands (L 3): "These monographs must be mature from a didactic point of view. Such teaching aids make studying very much easier. Subjects which are easy to unterstand, and that can be grasped in a single reading should not be dealt with at all in lectures, but given to students in written form in such monographs. In the basic sciences it would be of value if instruction did not vary so much from one establishment of higher education to the other. After all, mathematics, mechanics, simple physics etc., are the same in Aachen as in Munich.. It would be a waste of time, to compile these state-of-technological-development reports individually in various schools. These reports must be divided up amongst establishments of higher education."

Likewise interesting is the following recommendation of the Carnegie Commission on Higher Education in the USA (L 4): "Since a grossly inadequate supply of good quality instructional materials now exists, a major thrust of financial support and effort on behalf of instructional technology for the next decade should be toward the development and utilization of outstanding instructional programs and materials."

On the basis of all these arguments it seems to me that a system of interrelated textbooks of high quality would remove the deficiences mentioned before. This will be discussed in section 2.

1.2 The quality of teaching is often unsatisfying

Numerous efforts have been made in many countries during the past fifteen or twenty years to improve the educational systems However, they have had disappointingly little impact n the essential point of education, namely the quality of teaching.

Let us discuss *some* of the reasons for this unsatisfactory state. The composition of a course curriculum is a very extensive and complicated task, which the teacher is expected to fulfill besides his current duties. He has to make a great many decisions regarding details, e.g., in how far should the individual topics be studied more deeply, which formulae will be included in the examination requirements, how does he distribute the time he has at his disposal among the planed instructional contents, which exercises and revisions are necessary, which teaching methods are to be applied, which teaching materials are to be used, which aids are the students allowed to use in the examination. Everything must constantly be adapted to the latest scientific standards. The instructional content must be delimited to those of neighbouring courses, adapted to the given level of education, and related to practical needs. Besides these, many other aspects must be taken into consideration. All this together requires an enormous expenditure of work lasting several years, and that for only one course.

There is a large number of relevant literature available to the teacher who works out for his own use the curriculum of the course he offers. However, the greatest number of papers available give only the raw material for instruction, dealing only with single components of the curriculum. For example, textbooks usually contain only ordered instructional contents, and in others only methods of teaching are dealt with.

Only a very few textbooks contain a complete course curriculum ready for use.

Let us discuss some strategies which may bring about an improvement of the quality of teaching.

One of them may be to improve the training of the teachers, for example by offering them advice or additional courses in didactics or other relevant subject matter.

For this purpose, for example, centres for didactics have been established at many universities in West Germany during the past years.

The result of these efforts has however been unsatisfying, primarily because university teachers have neither enough time nor inclination to study those many papers dealing with problems of didactics and curriculum. This can partly be explained by the fact that they have already enough problems to keep up with and to evaluate the constant progress in their own discipline.

Another strategy, practised in many countries is to induce additional research in problems of teaching, including curriculum reform projects in order that their results can be used by the teachers. This strategy also has had little success, mainly because of the reasons mentioned above.

It can be concluded that the main cause of deficiences in teaching is the simple fact that the very difficult task to compose an unobjectionable curriculum in most cases cannot satisfactorily be fulfilled by one single person, not even then if the training of the teachers were improved. This leads us to consider the following strategy to improve the quality of teaching: Commissions of experts should develop high quality complete ready-to-use standard curricula for most of the courses beeing offered at universities and schools.

Such curricula would probably have a good chance of beeing used by the teachers as an example and a reliable aid for the planning of their (improved) lectures. This can be expected also because the teacher would in this way have to study only one reliable source indicating how to optimally form the lectures of the course offered.

Since this strategy seems to be promising, a procedure of developing a system of standard curricular units will be discussed in the next section.

2. System of polyvalent curricula (SPOC) - A new information system

2.1 Introduction

With the common conviction that standard curricula would contribute a great deal to an improvement of the teaching quality, 83 scientists from 29 countries have combined to plan the international project SPOC.

The aim of this project is the development of a system of interrelated standard curricular units for the entire educational system, including universities, in the form of curriculum textbooks. This system is called System of Polyvalent Curricular (SPOC). Unlike most of the currently available textbooks, the SPOC system will be distinguished by the following features: Instead of offering just ordered subject matter, the SPOC textbooks will contain complete, ready-to-use curricula. That means they must also describe the particular objectives and contain concrete suggestions for the organization of the lectures.

2.2 The structure of the SPOC

The SPOC is to be developed using the strategy described in the treatise "Skeleton Strategy for the Development of a System of Polyvalent Curricula for the Entire System of Education" (L 5). According to this strategy the instructional contents will be allotted to a system of curricular units (courses) by commissions of experts according to scientifically founded criteria.

The commissions must not select, favour or omit any objectives or instructional contents. Therefore only those specialists should be appointed to the commissions who, through the competence in their fields, make possible best quality and completeness of the SPOC.

An instructional content is allotted to a course of the (n+1)th level if, for comprehending its instructional contents, it is necessary that one has mastered the instructional contents of at least one course of the n-th level. Thus there is a deepening and widening of the instructional contents with the advancing succession of levels.

The structure of the SPOC is primarily determined by the requirement that each student has to be given the possibility to attain his (individual) objective with as little expenditure of work as possible.
This means among other things that the curricula of different courses must be mutually delimited and agreed upon. Thus for example the courses of the higher levels must build up on those of the lower ones.

Hence follows the necessity that the SPOC encompasses all of the instructional contents and all the sectors of the educational system, from nursery school to university.

The SPOC represents therefore a lucid, ordered system of subject matter which will make possible or easier an effective co-ordination of the work of many institutes and authors in the development of part-curricula, educational films, software for computer-aided teaching, and other teaching aids.

Because of the constant progress of science there will - in spite of the continuous revision and completion of the SPOC - always be a considerable amount of new instructional contents, which have not yet been included into the SPOC. Such new contents are usually offered in upper level courses at universities.

2.3 Modul 100 teaching hours

Every curriculum textbook covers a course of 100 teaching hours. One teaching hour lasts approximately 45 minutes. Since the courses here represent a kind of general purpose construction unit it is reasonable that all of them consist of the same number of lessons. In this way the organization of the instruction can be made easier and clearer. Professional qualifications become clearer for everybody if they are made up of the completion of courses of approximately the same quantity of information.

2.4 Catalogue of all courses

Every course and textbook gets a short designation, e.g. "5 CHEM 2". The first number indicates what SPOC level, and thus what academic level, the textbook has been assigned to. The letters and the following number contain information on the field beeing dealt with.

With the aid of a catalogue containing all courses with concise synopses of their instructional contents, arranged according to levels and branches, every student is given a complete view on a large scale of possible branches of education. For example it is the student himself who can decide how many courses of the 5th level he takes before he takes a course in the 6th level. The more courses he takes at one level, the greater is the number of different subjects he gets to know, i.e. the wider his knowledge is spread.

In order to help the student choose a favorable order of courses, each synopsis of a course states in which courses the prerequisites needed are given and for which courses the course in question gives the prerequisites.

2.5 Polyvalent course curricula

The curriculum of every course must be polyvalent as far as possible, i.e. it must be usable as a part of as many educational branches as possible. The valency of a course curriculum A is determined by the number of the courses for which A gives a part of the necessary prerequisites. Thus a polyvalent curriculum is principally not orientated towards a certain final objective. Instead of the many curricula of low valency, as for example "chemistry for biology students", "chemistry for chemistry students" etc., the instructional contents are grouped in polyvalent curricula in such a way that for example on the level 6 there is a course curriculum with instructional contents which are suitable for, say 20 courses of the levels higher than the 6th, whereas on the 7th level a branching out and specialization of the instructional contents takes place in several courses which means that those instructional contents are now only suitable for a smaller number, e.g. 12, of courses of the levels higher than the 7th. It is natural that with the increasing levels the valencies of the corresponding course curricula decrease.

2.6 Separation according to different valencies

It will be avoided, as far as possible, that instructional contents, the valencies of which show great differences appear within one and the same course.

This rule mainly serves the so called clearing out of the instructional contents. Thus a student can first register in courses of higher valency and afterwards, in case of special interest, also in those of lower valency. Learning foreign languages for example, one will first take courses of higher valencies teaching the most current words and grammar, and only those who want to master the language better will afterwards also register in further courses of lower valency of this language.

If, however, every course contained instructional contents of very different valencies, all students would be taught many (ballast) instructional contents which they do not need for their branch. This would lead to unnecessarily long educational periods.

2.7 Continuous revision

The rapid development in most fields of science requires a continuous adaptation of the curricula to the newest standards of knowledge. In order to make alterations and completions possible without difficulties, the SPOC text books must therefore, consist of exchangeable (loose-leaf) pages. The owner of a SPOC textbook will in the course of time receive new pages with alterations and with directions as to which old pages are to be replaced by them. Thus the user remains continuously informed about new findings in the corresponding field.

As this is not only a compiling of the numerous publications but the result of systematic evaluation of the entire available material, the SPOC textbooks will serve not only teachers and students but also working people as a permanently up-to-date and detailed work of reference, and as a reliable starting point for new investigatio Through this scientific works will be better co-ordinated, and new findings will be taken into account in the instruction within a shorter time than up to now.

The tedious constant systematic evaluation and processing of the numerous publications and the publication of the results of the evaluation have up to now been neglected which has also been deplored lately by H. Maier-Leibnitz (L 1).

2.8 Aid for teachers and students

The SPOC textbooks serve the teachers as an example and a reliable aid for the planning and execution of their lectures. The teacher finds there all of the necessary details for the realization of a flawless instruction; e.g., in how far he can concentrate on a topic more deeply and how much time he can afford for this and for the corresponding exercises if he wants to avoid running out of time towards the end of the course and then having to omit important topics because of it.

Curriculum textbooks are especially useful to teachers in their first years of teaching because then they still lack experience and assurance. The decision to use such ready made curricula can be made all the easier if the teacher knows that they have been developed by most competent specialists.

Since the students also have the corresponding textbook at their disposal they no longer have to frantically take notes of what the teacher is lecturing on. This applies primarily to the university courses for which very often there are no corresponding textbooks. Moreover the teacher does not have to present all of the provided instructional contents, but can confine himself to the essentials and the more complex parts of it. Thus more time is left for exercises, discussions and the answering of questions in the instruction.

At the present time a great deal of importance is beeing attached to permanent education (L 8). Young people can only become interested in and accustomed to it, if they are taught at an early age to work on their own. In order to achieve this aim, the texts in SPOC books are to be clear and lucid enough for students to understand them easily, so that to a great extent they can learn from them independently.

Students can continue their education without difficulty in any town or country where the SPOC is used.

2.9 Standardized qualifications

Every SPOC textbook is to contain a collection of the objectives in the form of general formulations as well as in the form of a corresponding catalogue of test questions or tasks which encompass the respective instructional contents as completely as possible. This collection can make the demands of the examination concerned recognizable, more objectivity in tests, and a standardization of examination requirements possible.

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JOINT STATEMENT

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JOINT STATEMENT

PREAMBLE

The three Conferences on 'Universities in World Network of Information and Communication' held in 1977, 1979 and 1980 at the Inter-University Centre for postgraduate studies in Dubrovnik, Yugoslavia, attracted some 150 participants from 15 countries. Papers and discussions at these Conferences progressed each year along these main common themes and problems:

1. Progress in developments of modern information technologies, computers and telecommunications in particular
2. Progress in developments of a variety of information sources and services, particularly data bases and similar ones based on information technology
3. Progress in developments of modern information systems and their application in a variety of institutions, from systems in universities to systems available or planned on a world wide basis
4. Deployment of information networks of various types, from data base networks to university networks and to multimedia networks
5. Information needs of a variety of populaces and institutions, particularly ir.cluding the information needs of developing countries, of science, and of universities
6. State and development of educational programmes necessary for education and training of specialists capable of responding to the information needs and to the needs for an integrated deployment of information technology, systems and networks
7. Allocation of a variety of resources necessary for any and all of these activities, and measuring of their effectiveness and efficiency
8. Structure of universities necessary to respond to the changes introduced by these information developments.

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CONCLUSIONS

The 30 participants from 8 countries of the Third Conference on Universities in World Network of Information and Communication agreed on the following:

Recognizing the need for international discussions on the effects of the rapidly growing and changing information technologies, systems, services and networks and on the problems of their effective and efficient deployment for betterment of a variety of social institutions and activities

Building upon the achievements of these three Conferences, particularly upon the progress in discussion of the themes recounted above

Acknowledging the needs of many social institutions and many levels of policy makers and professionals in relation to adjustments to the changing international information scene

Honouring the memory and work of the late Prof. Dr. Božo Težak, the founder of these Conferences

We suggest

1. To continue the work, studies and discussions inspired by these Conferences and to leave record of these by publication of presented papers either as Proceedings or as articles in recognized international journals, or as books
2. To organize the future work in two directions:
   A. Continue the series of Conferences, but with very specific themes from those already identified above
   B. Attempt to establish short courses for integrated training of the range of information specialists involved in deployment of modern information technologies, services, systems and networks
3. The series of Conferences shall be organized under the general heading 'Forum on Universities in World Network of Information and Communication' with Roman numerals afterwards indicating the number. The theme of the Conference shall then be indicated as the title and this may be changed from year to year.

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4. The theme and title of the next Conference shall be: 'Increase of Computer and Information Literacy'. The specific objective shall be to explore the problems associated with the widespread lack of knowledge related to *(i)* computers and information technology in general and *(ii)* modern information sources and services, and to the methods to alleviate them.

5. The theme and the title of the next Course shall be: 'Information Systems and Methods in Science, Technology and Management'.

   The Course shall be held from 18 to 30 May, 1981 at the Inter-University Center, Dubrovnik, Yugoslavia. The first week shall be devoted to information systems and methods in science and technology, and the second week to information systems and methods in management.

6. Publicity for the Course and Conference should be increased. An attempt should be made to establish a network of contact persons for the Course and Conference in different countries and institutions in general and in IUC member universities in particular. The role of these contact persons would be to promote the Course and Conference work and ideas and to help in recruitig prospective resource persons and participants, and in finding sponsors. The following people have agreed to serve as contact persons: Charles J. Bukowski (South Carolina), Ole Hafström (Arhus), Robert M. Hayes (Los Angeles), John Hawgood (Durham), Ulrich Neveling (Berlin), Sergei Prohorov (Kuibyshev), Tefko Saračević (Cleveland), Abdullah Uz Tansel (Ankara) and Ferenc Vajda (Budapest).

7. With great pleasure the participants are acknowledging the contribution to the success of the Conference of the Referral Center of the University of Zagreb, and in particular of Mrs. Neva Šilović and Miss Milica Milas of the Center. The IUC staff and Faculty made this Conference not only successful but also enjoyable, and that contribution is acknowledged.

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